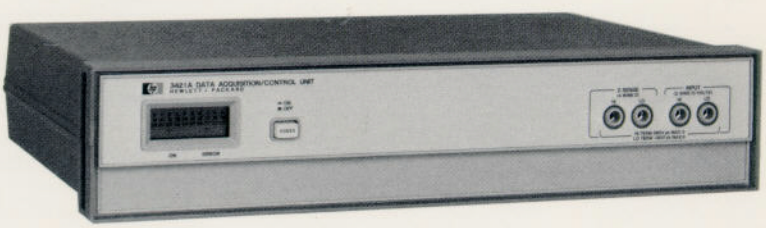
HP 3421A

SERVICE MANUAL

# DATA ACQUISITION AND CONTROL UNIT AND OPTIONS

## HP 3421A



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# INSTALLATION AND SERVICE MANUAL

# MODEL 3421A
# DATA ACQUISITION AND CONTROL UNIT
# AND OPTIONS

**Engineering Revision Codes (ERCs)**
**and Serial Number Prefix**

This manual applies to the following Engineering Revision Code numbers and mainframe Serial Number Prefix:

| Mainframe and Options | ERC Numbers | Serial Prefix |
|---|---|---|
| HP 3421A Mainframe | 2604 | 2338 |
| HP 44462A (Option 020, 021, or 022) | 2421 | N/A |
| HP 44465A (Option 050) | 2334 | N/A |
| HP 44461A (Option 201) | 2420 | N/A |
| Option 214 | 2607 | N/A |

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

**Manual Part No. 03421-90012**

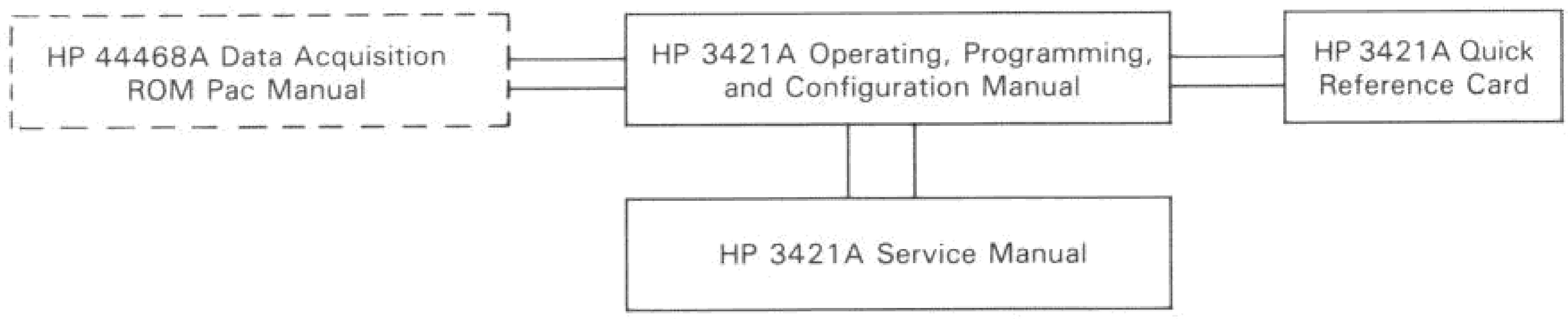
**Microfiche Part No. 03421-90062**


P.O. Box 301, Loveland, Colorado 80537 U.S.A

**Printed: February 1986**

# HP 3421A Manual Reference

The following block diagram shows the HP 3421A manual documentation scheme. Dashed line borders indicate those manuals shipped with the order of specific options; solid borders indicate those manuals that are shipped with every instrument.




HP 3421A Operating, Programming, and Configuration Manual (HP Part Number 03421-90010) is for all users. All features and options of the Model 3421A are discussed in this manual.

HP 3421A Quick Reference Card (HP Part Number 03421-90002) is for all users. This card is a quick reference to all of the Model 3421A commands.

HP 3421A Service Manual (HP Part Number 03421-90012) is for the service trained person. This manual has the mainframe and option theory of operation, applicable performance tests and calibration procedures, option installation procedures, and troubleshooting procedures. The manual includes the service information for the following:

1. HP 3421A Mainframe
2. HP 44462A Multiplexer/Actuator Assembly (Options 020, 021, and 022).
3. HP 44465A Digital I/O Assembly (Option 050).
4. HP 44461A HP-IB Assembly (Option 201).
5. 12 Vdc Power Adapter Option (Option 214).

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### Herstellerbescheinigung

Hiermit wird bescheinigt, daß das Gerät/System HP 3421A
in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

**Zusatzinformation fur Meß- und Testgeräte**

Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet, so ist vom Betreiber sicherzustellen, daß die Funk-Entstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

### Manufacturer's declaration

This is to certify that the equipment HP 3421A
is in accordance with the Radio Interference Requirements of Directive FTZ 1046/84. The German Bundespost was notified that this equipment was put into circulation, the right to check the series for compliance with the requirements was granted.

**Additional Information for Test- and Measurement Equipment**

If Test- and Measurement Equipment is operated with unscreened cables and/or used for measurements on open set-ups, the user has to assure that under operating conditions the Radio Interference Limits are still met at the border of his premises.

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## CERTIFICATION

*Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.*

## WARRANTY

This Hewlett-Packard instrument product is warranted against defects in materials and workmanship for a period of one year from date of shipment [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period]. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Duration and conditions of warranty for this instrument may be superceded when the instrument is integrated into (becomes a part of) other -hp- instrument products.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

## LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

## EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

## ASSISTANCE

*Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.*

*For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.*

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## SAFETY SUMMARY

**The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.**

### GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

### DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

### KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

### DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

### DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

### DO NOT OPERATE A DAMAGED INSTRUMENT

Whenever it is possible that the safety protection features built into this instrument have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the instrument until safe operation can be verified by service-trained personnel. If necessary, return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

### DANGEROUS PROCEDURE WARNINGS

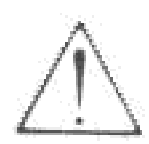
Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

**WARNING**

**Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.**

## SAFETY SYMBOLS

### General Definitions of Safety Symbols Used On Equipment or In Manuals.

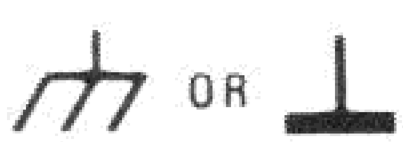


Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).


Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.




Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

**WARNING**

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

**CAUTION**

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which,if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE:

The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

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CHAPTER 1 - HP 3421A Mainframe Installation and Service Information

CHAPTER 5 - HP 3421A 12 Vdc Power Adapter Option (Option 214)
Installation and Service Information

# CHAPTER 1
# MODEL 3421A
# DATA ACQUISITION AND CONTROL UNIT
# MAINFRAME SERVICE INFORMATION

# CHAPTER 1

# MODEL 3421A DATA ACQUISITION AND CONTROL UNIT MAINFRAME SERVICE INFORMATION

**Serial Numbers**

This chapter applies directly to instruments with a serial number prefix of 2338. With changes in Section VII, this chapter also applies to instruments with serial prefixes of 2247, 2236, and 2218. If your instrument has some other serial prefix, updating information may be on a yellow *MANUAL CHANGES* supplement (located at the front of the manual).

**Engineering Revision Codes (ERCs)**

Engineering Revision Codes (ERCs) were implemented on this instrument with the introduction of the 03421-66511 motherboard. The present ERC is 2604. See Section VII of this chapter if your instrument has an ERC lower than 2604. If the ERC of your assembly is above 2604, updating information may be on a yellow *MANUAL CHANGES* supplement (located at the front of the manual).

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

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## LIST OF TABLES (Cont'd)

## LIST OF ILLUSTRATIONS

## LIST OF ILLUSTRATIONS (Cont'd)

# SECTION I
# GENERAL INFORMATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 1-1-1. INTRODUCTION

1-1-2. This chapter is intended for use by qualified service trained personnel only. Other individuals refer to the "HP 3421A Operating, Programming, and Configuration Manual".

1-1-3. The installation and service information of the HP 3421A mainframe is in this chapter. The chapter has eight sections that are assigned as follows:

**Section I - General Information**
This section describes the content of Chapter 1, has a brief description of the HP 3421A and its options, and lists the Model 3421A specifications.

**Section II - Installation**
This section explains the power requirements, line voltage selection, battery operation, and how to connect the Model 3421A via the HP-IL cables.

**Section III - Operation**
This section contains condensed operating instructions for service trained individuals.

**Section IV - Performance Verification and Calibration**
This section contains performance verification and calibration procedures for the HP 3421A mainframe.

**Section V - Adjustments**
This section normally has the adjustment procedures. However, since the Model 3421A has no adjustments, no procedures will be in this section.

**Section VI - Replaceable Parts**
For ease in obtaining part numbers, all the replaceable parts for the HP 3421A and *ALL* options are in this section. Ordering information, and all chassis and mechanical parts are also in this section.

**Section VII - Manual Changes**
This section contains information to update this chapter for use with HP 3421A mainframes that have serial number prefix, serial numbers, or ERC numbers different than shown on the title page of this chapter.

**Section VIII - Service**
This section has mainframe troubleshooting information, theory of operation, and schematics that are arranged in Service Groups.

## 1-1-4. INSTRUMENT DESCRIPTION

1-1-5 The HP 3421A is a versatile low cost data acquisition and control unit. When connected to a computer that supports HP-IL, such as the HP-85 or HP-41C/CV, the Model 3421A forms an easy to use data acquisition and control system. To expand I/O capabilities to several different controllers, the Model 3421A can be equipped with an HP-IB Option. A factory installed 12 Vdc Power Adapter Option is also available in lieu of the HP-IB Option. The instrument cannot be equipped with both the HP-IB Option and the 12 Vdc Power Adapter Option at the same time.

1-1-6. The standard HP 3421A consists of a mainframe, built-in 5½ digit voltmeter, 10 kHz counter, and an HP-IL I/O interface. The mainframe can accomodate up to three I/O option assemblies, plus an HP-IB Option or 12 Vdc Power Adapter Option. The available options include a Multiplexer/Actuator Assembly, an 8-bit Digital Input/Output Assembly, and a Breadboard Assembly.

1-1-7. Typically, the HP 3421A is equipped with at least one Multiplexer/Actuator Assembly (Option 020, 021, or 022). The option provides ten channels for inputting measurements and has a temperature reference junction for thermocouple compensation. Compensation for T-type thermocouples is built into the mainframe firmware. Two of the ten channels can be configured as actuators for controlling motors, alarms, etc.

1-1-8. The 8-bit Digital I/O Assembly (Option 050) provides an 8-bit input port and an 8-bit output port. Typical uses for this assembly include monitoring limit and position switches, and low current/low voltage actuators.

1-1-9. The breadboard option gives the design engineer or technician the capability of implementing a custom designed circuit for use with the HP 3421A.

### 1-1-10. SERIAL NUMBERS

1-1-11. The HP 3421A is assigned a serial number that can be found on the rear panel in the following form: 0000A00000. The serial number has two parts: the first four digits and the letter are the prefix; the last five digits are the suffix. Usually, the prefix is the same for all identical units manufactured. The suffix, however, is assigned sequentially and is different for each unit manufactured. This chapter applies directly to instruments with a serial number prefix listed on the title page of this chapter.

1-1-12. Your HP 3421A may have a serial number prefix different than listed on the title page. This indicates that your Model 3421A may be different than what is described in the manual. If this is the case, refer to Section VII of this chapter for backdating information. If the information is not listed in Section VII, it may be on a yellow MANUAL CHANGES supplement (located at the front of the manual).

1-1-13. In addition to change information, the Manual Changes Supplement may contain information for correcting errors in this manual. For information concerning a serial number prefix that is not listed on the title page, or in the Manual Changes Supplement, contact your nearest Hewlett-Packard Sales and Service Office.

### 1-1-14. PRINTED CIRCUIT BOARD IDENTIFICATION

1-1-15. The motherboard is identified by the board number and the engineering revision code. These two numbers identify the electrical characteristics of the circuit board. The engineering revision code and board part number are listed on the schematic, component locator, and replaceable parts list.

1-1-16. In any service related correspondence, identify the printed circuit board by using the board number followed by the engineering revision code. For example:

03421-66511-2310

would identify a motherboard board having an engineering revision code of 2310.

#### 1-1-17. Board Part Number

1-1-18. The HP part number of the printed circuit board is etched on the pc board. It is a ten digit number, separated by a hyphen into two groups of five digits. The first five digits identify the model or assembly number; the last five digits are unique to the assembly.

#### 1-1-19. Engineering Revision Code (ERC)

1-1-20. The engineering revision code (ERC) is changed whenever a change is made to the assembly. The change could be a printed circuit board revision, a component value change, added or deleted components, a component part number change, or a revised test and assembly procedure. ERCs were implemented on this instrument and its options with the introduction of the 03421-66511 motherboard. The first ERC was 2334.

1-1-21. A typical ERC label is shown in Figure 1-1-1. It is the only label on the pc board that has a four digit number. This four digit code is in the form of YYWW, where YY is the last two digits of the year minus 60, and WW is the week. For example, an ERC of 2310 would identify the last revision to the assembly was in the tenth week of 1983.

2310

**Figure 1-1-1. Typical Engineering Revision Code (ERC) Label**

1-1-22. The ERC is listed on schematics, component locators, and parts lists. If the ERC of your assembly is lower than the one listed, refer to Section VII of the applicable chapter for backdating. If the ERC is higher than the one listed, this manual should be accompanied by a yellow *MANUAL CHANGES* supplement.

## 1-1-23. ACCESSORIES AND OPTIONS

1-1-24. The available options and accessories for the HP 3421A are listed in Tables 1-1-1 and 1-1-2, respectively.

**Table 1-1-1. Model 3421A Options and Field Installation Kits**

| HP Model No. if Ordered Separately | HP Model/Option No. if Ordered with 3421A | Description |
|---|---|---|
| 44461A* | 201 | HP-IB Option. |
| 44462A* | 020 | 8-channel Multiplexer/2-channel Actuator with thermocouple reference and connector block. |
| ---- | 021 | 9-channel Multiplexer/1-channel Actuator with thermocouple reference and connector block. |
| ---- | 022 | 10-channel Multiplexer with thermocouple reference and connector block. |
| 44463A* | 44463A | Extra connector block for multiplexer card. |
| 44464A* | 040 | Breadboard Assembly with connector block. |
| 44465A* | 050 | 8 bit in/8 bit out Digital I/O Assembly with connector block. |
| 44466A* | 44466A | Extra connector block for HP 44464A or 44465A. |
| 44468A* | 44468A | HP-41CV Data Acquisition Pac for programming the Model 3421A. |
| 44469A* | 44469A | Seven pairs of resistors for 10:1 300 Vac divider. |
| ---- | 214 | Add 12 Vdc Power Adapter Option. |
| Order components separately | 541 | Add HP-41C Computer, HP 82160A HP-IL Interface, HP 82182A Time Module, and HP 44468A DA/C Pac. |
| 82161A | 561 | HP 82161A HP-IL Digital Cassette Drive. |
| 82162A | 562 | HP 82162A HP-IL Printer. |
| ---- | 401 | Side Handle Kit. |
| ---- | 907 | Front Handle Kit. |
| ---- | 908 | Rack Mount Kit. |
| ---- | 909 | Rack Mount with Handle. |
| Order by part no. | 910 | Additional Operating, Programming, and Configuration Manual, and Service Manual. |

*Field Installation Kits

Table 1-1-2. Model 3421A Accessories

| Accessory Number | Description |
|---|---|
| 10023A | Temperature Probe. |
| 11096B | 500 MHz RF Probe. |
| 34118A | Test Lead Kit |
| 10833A | 1 Metre HP-IB Cable |
| 10833B | 2 Metre HP-IB Cable. |
| 10833C | 4 Metre HP-IB Cable. |
| 10833D | 0.5 Metre HP-IB cable |
| 82167A | 0.5 Metre HP-IL Cable. |
| 82167B | 1 Metre HP-IL Cable. |
| 82167D | 5 Metre HP-IL Cable. |
| 11341A | HP 3421A Carrying Case (holds HP-41C/CV Handheld Computer). |
| 11351B | HP 3421A Carrying Case (holds HP-75C Personal Computer). |
| 03421-66504 | Diagnostic Terminal Block (for testing Multiplexer and Digital I/O Assemblies. |
| 03421-66505* | Temperature Calibrator Board (for calibrating the Multiplexer Assemblies). |
| 03421-10001 | HP 3421A Calibration and Performance Verification Program Tape (for semi-automated test and calibration of the HP 3421A and its options). |
| 03421-67901 | Includes the Diagnostic Terminal Block, Temperature Calibrator Board, Calibration and Performance, Verification Program Tape, and instructions on how to use them. |

*The Temperature Calibrator Board is shipped with each ordered Multiplexer/Actuator Assembly

## 1-1-25. SEMI-AUTOMATED TEST AND CALIBRATION EQUIPMENT

1-1-26. The following test equipment is available to do semi-automated tests and calibrations of the HP 3421A mainframe and Options 020, 021, 022, and 050. This equipment can be ordered under HP Part Number 03421-67901, which includes instructions on how to use the equipment with the Model 3421A, and the Multiplexer/Actuator and Digital I/O Assembly. The equipment is explained as follows:

### 1-1-27. Diagnostic Terminal Block

1-1-28. The Diagnostic Terminal Block is a test fixture that can be used to run verification tests on the HP 3421A Options 020, 021, 022, and 050. This is done using an HP-41C/CV Handheld Computer or an HP-85 Personal Computer. The HP-41C/CV must be equipped with the HP 44468A Data Acquisition Pac ROM to use the test fixture. To use the fixture using an HP-85, you must have the HP 3056DL software package or the HP 3421A Calibration and Test Tape Cartridge (see next paragraph). The Diagnostic Terminal Block can be ordered under HP Part Number 03421-66504.

### 1-1-29. Model 3421A Calibration and Test Tape Cartridge

1-1-30. The HP 3421A Calibration and Test Tape Cartridge contains routines to perform semi-automated calibration and performance tests on the Model 3421A and the Multiplexer/Actuator Assembly A routine to test the Digital I/O Assembly using the Diagnostics Terminal Block is also included. In addition, the tape also includes a loop test that can be used to repeatedly exercise the HP 3421A dc volts, ac volts, and ohms functions. This is useful in detecting intermittent errors. The HP 3421A Calibration and Test Tape Cartridge can be ordered under HP Part Number 03421-10001.

### 1-1-31. Temperature Calibrator Board

1-1-32. The Temperature Calibrator Board is used to perform the temperature calibration of the Multiplexer/Actuator options installed in the Model 3421A. It can be used with both the manual and semi-automated temperature calibration procedure. If the semi-automated procedure is used with this board, make sure the HP 3421A Calibration and Test Tape Cartridge is a Revision C or above. The board is presently shipped with the HP 3421As that have an Option 020, 021, or 022 installed, and also with each field installable Multiplexer/Actuator option (i.e., HP Model 44462A). This board replaces the thermistor that has previously been shipped with older Model 3421As. The board can be ordered under HP Part Number 03421-66505.

### 1-1-33. SPECIFICATIONS

1-1-34. The HP 3421A specifications are listed in Table 1-1-3. These specifications are the performance standards or limits to which the instrument can be tested.

**Table 1-1-3. HP 3421A Specifications**

## DC VOLTAGE

**Input Characteristics**

| Range | Maximum Display (5½ Digit) | Resolution 5½ Digit | 4½ Digit | 3½ Digit | Input Resistance | 0-40°C @ 65% < RH ≤ 95% Input Resistance | Maximum Input Voltage |
|---|---|---|---|---|---|---|---|
| 0.3V | .3010000 | 1 µV | 10 µV | 100 µV | $>10^{10}$ | $10^8$ | ±350 Vpeak Hi-earth. |
| 3 V | 3.01000 | 10 µV | 100 µ | 1 mV | $>10^{10}$ | $10^8$ | ±300 Vpeak |
| 30 V | 30.1000 | 100 µV | 1 mV | 10 mV | 10M ± 1% | 10M + 1% − 9% | Hi-Lo |
| 300 V | 301.000 | 1 mV | 10 mV | 100 mV | 10M ± 1% | 10M + 1% − 9% | ±150 Vpeak Lo-earth. |

**Measurement Accuracy:** ±(% of reading + number of counts). Auto-zero on. (20°C ≤ calibration temperature ≤ 30°C)

**24 hours:** 23°C ± 1°C operating temperature after 1 hour warmup. For less than 1 hour warmup use 90 day specs.

| Range | 5½ Digit | 4½ Digit | 3½ Digit |
|---|---|---|---|
| 0.3 V | .0050 + 5 | .0050 + 1 | .0050 + 1 |
| 3 V | .0035 + 3 | .0035 + 1 | .0035 + 1 |
| 30 V | .0050 + 3 | .0050 + 1 | .0050 + 1 |
| 300 V | .0055 + 3 | .0055 + 1 | .0055 + 1 |

**90 days:** 23°C ± 5°C operating temperature

| Range | 5½ Digit | 4½ Digit | 3½ Digit |
|---|---|---|---|
| 0.3 V | .0088 + 6 | .0088 + 1 | .0088 + 1 |
| 3 V | .0072 + 3 | .0072 + 1 | .0072 + 1 |
| 30 V | .0087 + 3 | .0087 + 1 | .0087 + 1 |
| 300 V | .0089 + 3 | .0089 + 1 | .0089 + 1 |

**1 year:** 23°C ± 5°C operating temperature

| Range | 5½ Digit | 4½ Digit | 3½ Digit |
|---|---|---|---|
| 0.3 V | .0194 + 6 | .0194 + 1 | .0194 + 1 |
| 3 V | .0181 + 3 | .0181 + 1 | .0181 + 1 |
| 30 V | .0195 + 3 | .0195 + 1 | .0195 + 1 |
| 300 V | .0195 + 3 | .0195 + 1 | .0195 + 1 |

**Temperature Coefficient:** Add to Measurement Accuracy ±(% of reading + number of counts)/°C for each °C outside of calibration temperature ± 5°C, within the range of 0°C to 55°C.

| Range | 5½ Digit | 4½ Digit | 3½ Digit |
|---|---|---|---|
| 0.3V | 0.0008 + 0.5 | 0.0008 + 0.05 | 0.0008 + 0 |
| 3 V | 0.0007 + 0.05 | 0.0007 + 0 | 0.0007 + 0 |
| 30 V | 0.0008 + 0.5 | 0.0008 + 0.05 | 0.0008 + 0 |
| 300 V | 0.0007 + 0.05 | 0.0007 + 0 | 0.0007 + 0 |

**Auto-zero Off:** Add to Measurement Accuracy ± (number of counts). For 24 hours in a stable environment (temperature within ± 1°C of the temperature when auto-zero is turned off).

| Range | 5½ Digit | 4½ Digit | 3½ Digit |
|---|---|---|---|
| 0.3V | 11 | 1 | 0 |
| 3 V | 3 | 0 | 0 |
| 30 V | 11 | 1 | 0 |
| 300 V | 3 | 0 | 0 |

**Noise Rejection:** For 50, 60 Hz ± 0.1% (depending on option). 1 kΩ unbalance in Lo. Auto-zero on.

| In dB | ≤85%RH @ 30°C 5½ Digit | 4½ Digit | 3½ Digit | 0-40°C @ 65% < RH ≤ 95% 5½ Digit | 4½ Digit | 3½ Digit |
|---|---|---|---|---|---|---|
| AC NMR | 80 | 59 | 0 | 80 | 59 | 0 |
| AC ECMR | 140 | 120 | 60 | 140 | 120 | 60 |
| DC CMR | 140 | 140 | 140 | 120 | 120 | 120 |

## Table 1-1-3. HP 3421A Specifications (Cont'd)

### RESISTANCE (2-wire Ω, 4-wire Ω)

**Input Characteristics**

| Range | Maximum Reading 5½ Digit | Resolution 5½ Digit | Resolution 4½ Digit | Resolution 3½ Digit | Current Through Unknown | Max. Open Circuit Voltage |
|---|---|---|---|---|---|---|
| 300 Ω | 301.000 | 1 mΩ | 10 mΩ | 100 mΩ | 1 mA | 6.5 |
| 3 k | 3.01000 | 10 mΩ | 100 mΩ | 1 Ω | 1 mA | 6.5 |
| 30 k | 30.1000 | 100 mΩ | 1 Ω | 10 Ω | 100 μA | 6.5 |
| 300 k | 301.000 | 1 Ω | 10 Ω | 100 Ω | 10 μA | 5.5 |
| 3 M | 3.01000 | 10 Ω | 100 Ω | 1 kΩ | 1 μA | 4.5 |
| 30 M | 30.1000 | 100 Ω | 1 kΩ | 10 kΩ | 100 nA | 4.5 |

Non-destructive over load ± 300 Volts peak.
Short-term overload ± 650 Volts peak.

### RESISTANCE (2-wire Ω, 4-wire Ω) (Continued)

**Measurement Accuracy:** ±(% of reading + number of counts).
Auto-zero on. 4-wire ohms.

**5½ Digit Mode**

| Operating Temperature | 23°C ± 1°C | 23°C ± 5°C | 23°C ± 5°C |
|---|---|---|---|
| **Range** | **24 Hour** | **90 Day** | **1 Year** |
| 300 Ω | .0045 + 5 | .012 + 6 | .017 + 6 |
| 3 k | .0035 + 3 | .011 + 3 | .016 + 3 |
| 30 k | .0035 + 3 | .011 + 3 | .016 + 3 |
| 300 k | .0035 + 3 | .011 + 3 | .016 + 3 |
| 3 M | .010 + 3 | .014 + 3 | .018 + 3 |
| 30 M | .092 + 3 | .107 + 3 | .115 + 3 |

| Operating Environment | 0-40°C @ 65% < RH ≤ 95% | | |
|---|---|---|---|
| **Range** | **24 Hour** | **90 Day** | **1 Year** |
| 300 Ω | .0046 + 4 | .012 + 6 | .017 + 6 |
| 3 k | .0047 + 3 | .011 + 3 | .017 + 3 |
| 30 k | .0318 + 3 | .0335 + 3 | .0354 + 3 |
| 300 k | .315 + 3 | .315 + 3 | .315 + 3 |
| 3 M | 3.08 + 3 | 3.08 + 3 | 3.08 + 3 |
| 30 M | 25.2 + 3 | 25.2 + 3 | 25.2 + 3 |

**4½ Digit Mode**

| Operating Temperature | 23°C ± 1°C | 23°C ± 5°C | 23°C ± 5°C |
|---|---|---|---|
| **Range** | **24 Hour** | **90 Day** | **1 Year** |
| 300 Ω | .0045 + 1 | .012 + 1 | .017 + 1 |
| 3 k | .0035 + 1 | .011 + 1 | .016 + 1 |
| 30 k | .0035 + 1 | .011 + 1 | .016 + 1 |
| 300 k | .0035 + 1 | .011 + 1 | .016 + 1 |
| 3 M | .010 + 1 | .014 + 1 | .018 + 1 |
| 30 M | .097 + 1 | .114 + 1 | .123 + 1 |

| Operating Environment | 0-40°C @ 65% < RH ≤ 95% | | |
|---|---|---|---|
| **Range** | **24 Hour** | **90 Day** | **1 Year** |
| 300 Ω | .0046 + 1 | .012 + 1 | .017 + 1 |
| 3 k | .0047 + 1 | .011 + 1 | .017 + 1 |
| 30 k | .0318 + 1 | .0335 + 1 | .0354 + 1 |
| 300 k | .315 + 1 | .315 + 1 | .315 + 1 |
| 3 M | 3.08 + 1 | 3.08 + 1 | 3.08 + 1 |
| 30 M | 25.2 + 1 | 25.2 + 1 | 25.2 + 1 |

**3½ Digit Mode**

| Operating Temperature | 23°C ± 1°C | 23°C ± 5°C | 23°C ± 5°C |
|---|---|---|---|
| **Range** | **24 Hour** | **90 Day** | **1 Year** |
| 300 Ω | .0045 + 1 | .012 + 1 | .017 + 1 |
| 3 k | .0035 + 1 | .011 + 1 | .016 + 1 |
| 30 k | .0035 + 1 | .011 + 1 | .016 + 1 |
| 300 k | .0035 + 1 | .011 + 1 | .016 + 1 |
| 3 M* | .076 + 1 | .082 + 1 | .087 + 1 |
| 30 M* | .74 + 1 | .78 + 1 | .79 + 1 |

*3½ digit 3M and 30M spec is for ac operation with floating input. Measurement noise will decrease with LO connected to EARTH or in battery operation in which case the spec is the same as for 5½ digit with 0 counts offset.

| Operating Environment | 0-40°C @ 65% < RH ≤ 95% | | |
|---|---|---|---|
| **Range** | **24 Hour** | **90 Day** | **1 Year** |
| 300 Ω | .0046 + 1 | .012 + 1 | .017 + 1 |
| 3 k | .0047 + 1 | .011 + 1 | .017 + 1 |
| 30 k | .0318 + 1 | .0335 + 1 | .0354 + 1 |
| 300 k | .315 + 1 | .315 + 1 | .315 + 1 |
| 3 M* | 3.08 + 1 | 3.08 + 1 | 3.08 + 1 |
| 30 M* | 25.2 + 1 | 25.2 + 1 | 25.2 + 1 |

*3½ digit 3M and 30M spec is for ac operation with floating input. Measurement noise will decrease with LO connected to EARTH or in battery operation in which case the spec is the same as for 5½ digit with 0 counts offset.

## Table 1-1-3. HP 3421A Specifications (Cont'd)

First reading is in specification with default delay and 200 pF of capacitance.

2-wire ohms accuracy is the same as 4-wire ohms except add a maximum of 4Ω offset.

**Temperature Coefficient of Measurement Accuracy:**

0°C to 18°C, 28°C to 55°C
5½ digit display, auto-zero on
±(% reading + number of counts)/°C

| Range | Temperature Coefficient |
|---|---|
| 300 Ω | .0009 + 0.5 |
| 3 k | .0009 + .05 |
| 30 k | .0009 + .05 |
| 300 k | .0009 + .05 |
| 3 M | .0021 + .05 |
| 30 M | .021 + .05 |

For 4 digits, multiply counts by .1
For 3 digits, multiply counts by .01

**Auto-zero Off:** (5½ digits)

For a stable environment (±1°C) add 11 counts for 300Ω range, 3 counts for 3k through 300k ranges, 8 counts for 3M and 33 counts for 30M range. For 4½ or 3½ digits, multiply counts by .1 and .01 respectively. Changes in lead resistance are not corrected in 4-wire ohms with auto-zero off.

**Current Source Accuracy:** 2.7%

**Maximum Lead Impedance:** 4-wire Ω

| | | |
|---|---|---|
| Ω sense leads | 10k | All ranges |
| Ω source lo lead | 1/30 of full scale | All ranges |
| Ω source hi lead | 1/3 of full scale<br>3kΩ for 300Ω | 3k through 30M |

| Source Lead | 300Ω | 3kΩ | 30kΩ | 300kΩ | 3MΩ | 30MΩ |
|---|---|---|---|---|---|---|
| Lo | 10 | 100 | 1k | 10k | 100k | 1M |
| Hi | 3k | 1k | 10k | 100k | 1M | 10M |

## AC VOLTAGE

**Input Characteristics**

| Range | Maximum Display (4½ Digit) | 4½ Digit Resolutioin | Input Resistance | Maximum Input Voltage |
|---|---|---|---|---|
| 3 V | 3.0100 | 100μV | 10MΩ ± 1% | Hi – Lo ±30V peak Lo terminal to earth: ±150V peak |
| 30 V | 30.100 | 1 mV | 10MΩ ± 1% | |

**Measurement Accuracy*:** ±(% Reading + Counts) (90 days)

| | 30 Hz – 1kHz | 45 Hz – 500 Hz | Temperature Coefficient ±(%Reading + Counts)/°C 0–18°C, 28–55°C |
|---|---|---|---|
| 3½ Digits | 1 + 6 | 0.5 + 6 | .01 + 7 |
| 4½ Digits | 1 + 60 | 0.5 + 60 | .01 + 7 |

*These specifications assume: $V_{in} > 0.3V$ (3V Range)
$V_{in} > 3V$ (30V Range)

## COUNTER

AC coupled zero crossing

**Frequency range:**

1 Hz to 10 kHz with rise time <1.5 ms
10 Hz to 10 kHz with rise time >1.5 ms

**Sensitivity:** 600 mV p-p

**Minimum pulse width (5V):**

50 μsec, 5% duty cycle minimum

**Accuracy:** (.05% of reading + 1 Count)

**Maximum input voltage:** 300V

**Maximum DC offset:** 2V

**Input impedance:** 10M + 1 − 10%

## TOTALIZE MODE

**Minimum pulse width (5V):**

50 μsec, 5% duty cycle minimum for signals with period 1 second

**Sensitivity:** 600 mV

**Maximum counts:** 65,535

**Maximum rise time for signals less than 10 Hz:** 1.5 ms

**Minimum pulse period:** 100 μsec

**Maximum input voltage:** 300V

**Maximum DC offset:** 2V

**Input impedance:** 10M + 1 − 10%

Table 1-1-3. HP 3421A Specifications (Cont'd)

## BATTERY LIFE

**Battery life from full charge:**

HP-IB – 6 hours minimum

**Battery charge rate from minimum to full charge:**

16 hours if HP 3421A off or asleep
21 hours if HP 3421A is on

## HP 3421A READING SPEEDS – INTO INTERNAL MEMORY (READINGS/SEC) REPEAT ON ONE CHANNEL

| | Z1F1 | Z0F1 | Z1F2 | Z0F2 | Z1F3 | Z0F3 | F6 | | F7 |
|---|---|---|---|---|---|---|---|---|---|
| **N5** | 2.26 | 4.08 | | | 2.26 | 4.12 | 1.05 | **G-1** | 8.4 |
| **N4** | 15.85 | 23.92 | .91 | 1.11 | 15.85 | 24.31 | 1.05 | **G0** | .98 |
| **N3** | 30.96 | 38.56 | 1.37 | 1.41 | 30.93 | 38.31 | 1.05 | **G1** | 1 |

## RANDOM CHANNEL

| | Z1F1 | Z0F1 | Z1F2 | Z0F2 | Z1F3 | Z0F3 | F6 | | F7 |
|---|---|---|---|---|---|---|---|---|---|
| **N5** | 2.19 | 3.98 | | | 2.19 | 3.99 | .98 | **G-1** | 7.59 |
| **N4** | 13.18 | 18.34 | .90 | 1.08 | 13.20 | 18.61 | .98 | **G0** | .97 |
| **N3** | 22.22 | 25.99 | 1.35 | 1.39 | 22.19 | 26.01 | .98 | **G1** | .1 |

N5, N4, N3 = 5½, 4½, 3½ digit mode

Z1 = Auto-Zero On
Z0 = Auto-Zero Off
F1 = DC Volts
F2 = AC Volts
F3 = Ohms
F6 = Temperature (T-type)
F7 = Frequency
G-1 = .1 second gate time
G0 = 1 second gate time
G1 = 10 second gate time

# SECTION II
# INSTALLATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 1-2-1. INTRODUCTION

1-2-2. This section contains the following information:

Initial Inspection - paragraph 1-2-3.
Power Requirements - paragraph 1-2-6.
Line Frequency and Line Voltage Selection - paragraph 1-2-8.
Power Cords and Receptacles - paragraph 1-2-11.
HP-IL Interface Connections - paragraph 1-2-13.
Option Board Connections - paragraph 1-2-16.
Environmental Requirements - paragraph 1-2-18.
Repackaging for Shipment - paragraph 1-2-23.
Where to Ship Your Instrument for Repair - paragraph 1-2-26.

## 1-2-3. INITIAL INSPECTION

1-2-4. The HP 3421A was carefully inspected for mechanical and electrical defects before it left the factory. It should be free of mars and scratches and in proper working order upon receipt. When you unpack the instrument, keep the shipping carton and cushioning material until the contents have been checked for completeness and the instrument has been checked mechanically and electrically. The electrical performance verification is given in Section IV of this chapter.

1-2-5. If the contents are not complete, if there is mechanical damage or defect, or if the instrument does not pass the performance tests, promptly notify the nearest Hewlett-Packard Sales and Service Office. A list of these offices is located at the end of this manual. If the shipping carton is damaged, or if the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard Office and keep the shipping materials for the carrier's inspection. The sales and service office will arrange for repair or replacement of your instrument (at HP option) without waiting for the claim against the carrier to be settled.

## 1-2-6. POWER REQUIREMENTS

1-2-7. The HP 3421A requires an ac power source of 100V, 120V, 220V, or 240V (-10% to +5%), 48 to 440 Hz single phase when operated from the ac line. The maximum power consumption is 6 VA. The line voltage to which the instrument is preset is indicated on the rear panel. Make sure the box checked is the same as the nominal line voltage for your area. Also, inspect the 50/60 Hz switch on the rear panel for the proper setting. This switch should be up for 60 Hz operation and down for 50 Hz operation.

### 1-2-8. Line Frequency and Line Voltage Selection

**1-2-9. Line Frequency Switch.** The line frequency switch is located on the HP 3421A rear panel. This switch is used to select 50 Hz or 60 Hz line rejection and should therefore be set to the line frequency of your area. This is shown in Figure 1-2-1. When the HP 3421A is operating on ac line frequencies other than 50 or 60 Hz, ac line rejection is substantially reduced, and the specifications listed in Table 1-1-3 cannot be guaranteed.

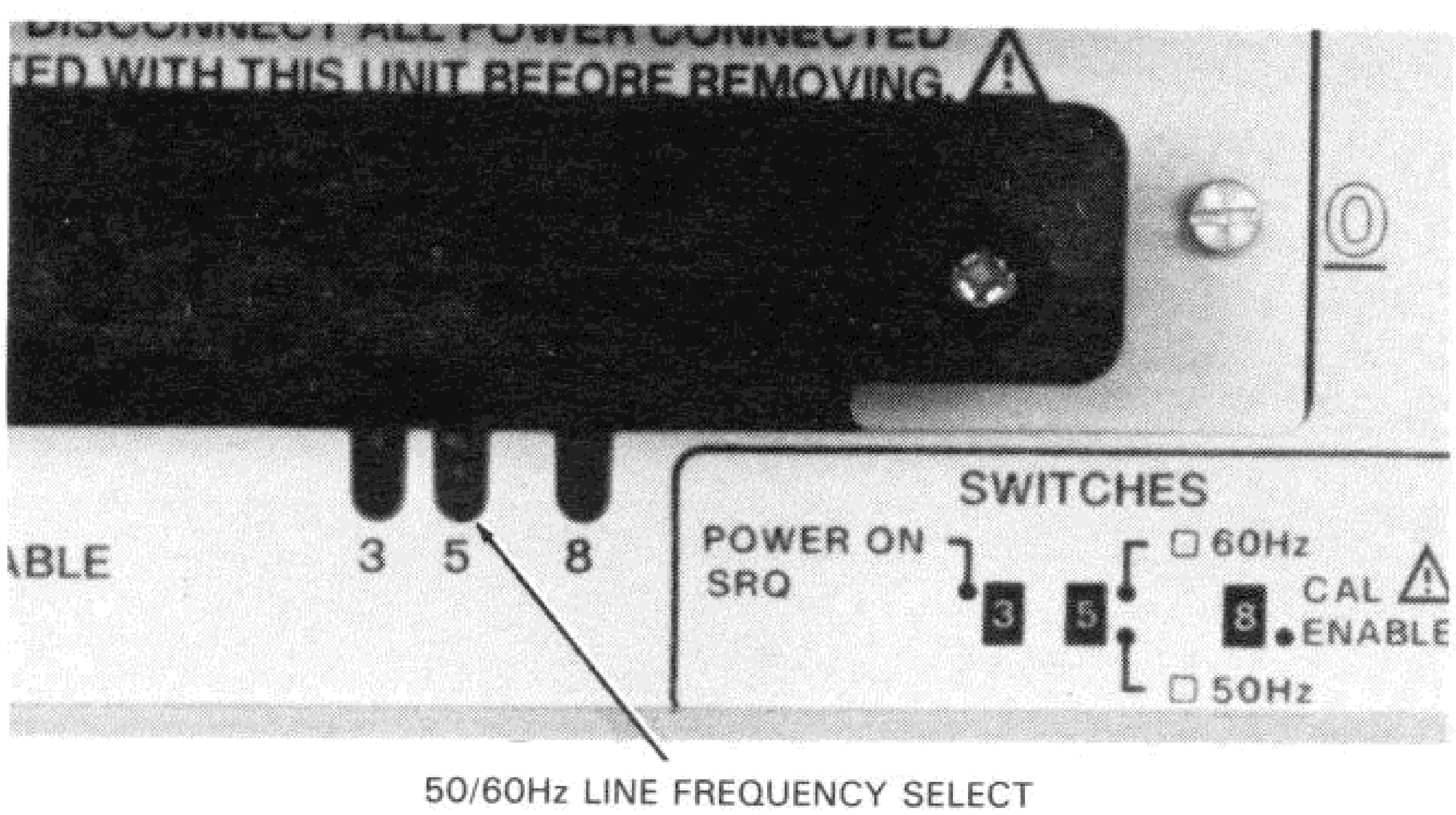



**Figure 1-2-1. AC Line Frequency Switch**

**1-2-10. Line Voltage Selection.** To verify or change the line voltage, the HP 3421A top cover needs to be removed. Do the following:

a. Make sure the ac power cord is disconnected from the instrument. Also make sure all external sources of power have been removed from the option terminal blocks.

b. Turn the instrument upside down. This is preferably done on top of a protective mat to reduce the possibility of scratching or marring the instrument case. Refer to Figure 1-2-2 and loosen the six screws on the instrument bottom.

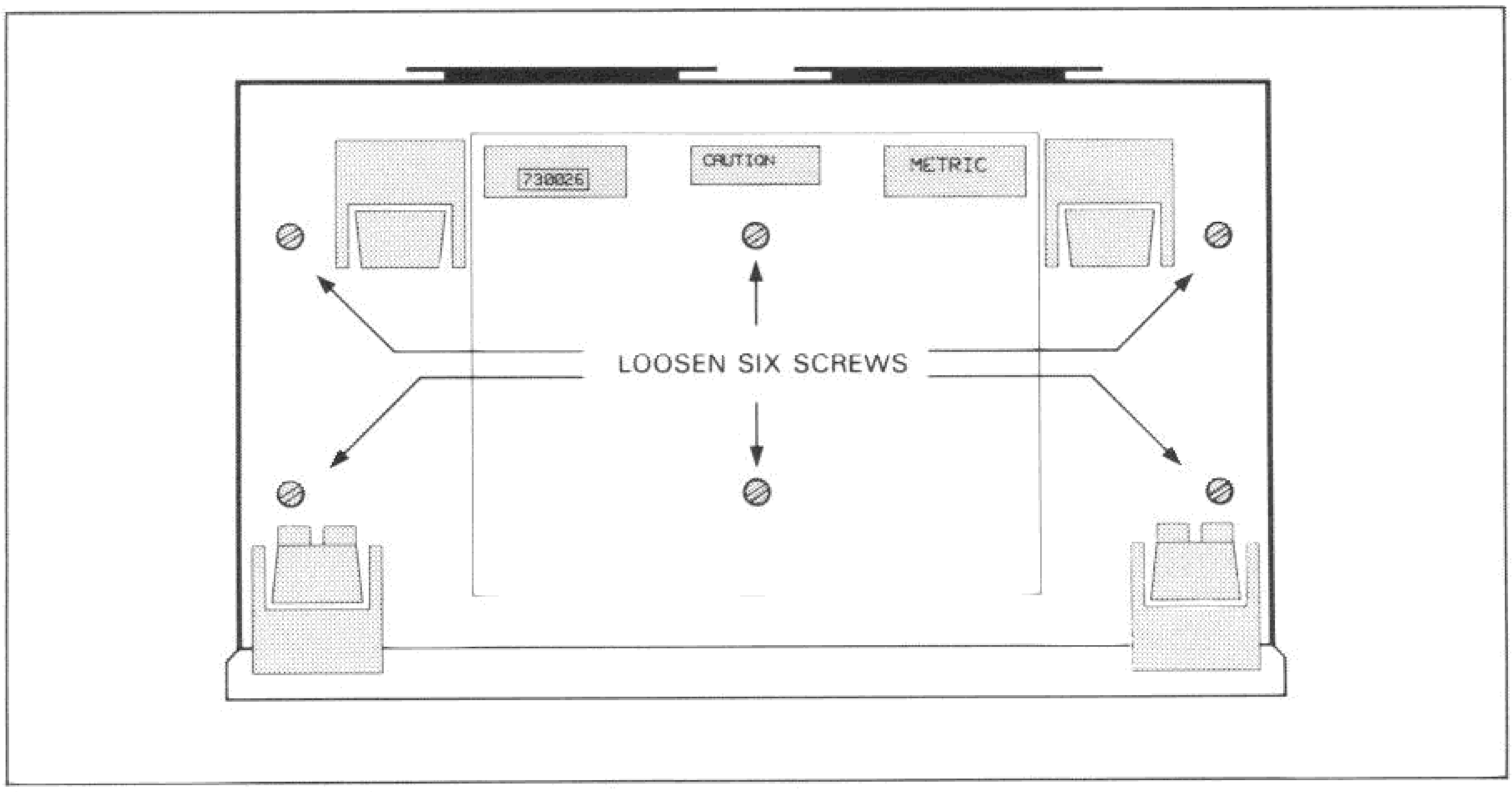



**Figure 1-2-2. HP 3421A Disassembly**

c. Hold the top cover in place and turn the instrument upright. Then remove the top cover.

d. Refer to Figure 1-2-3 and locate the line voltage select wire and four terminals next to fuse holder FX701.

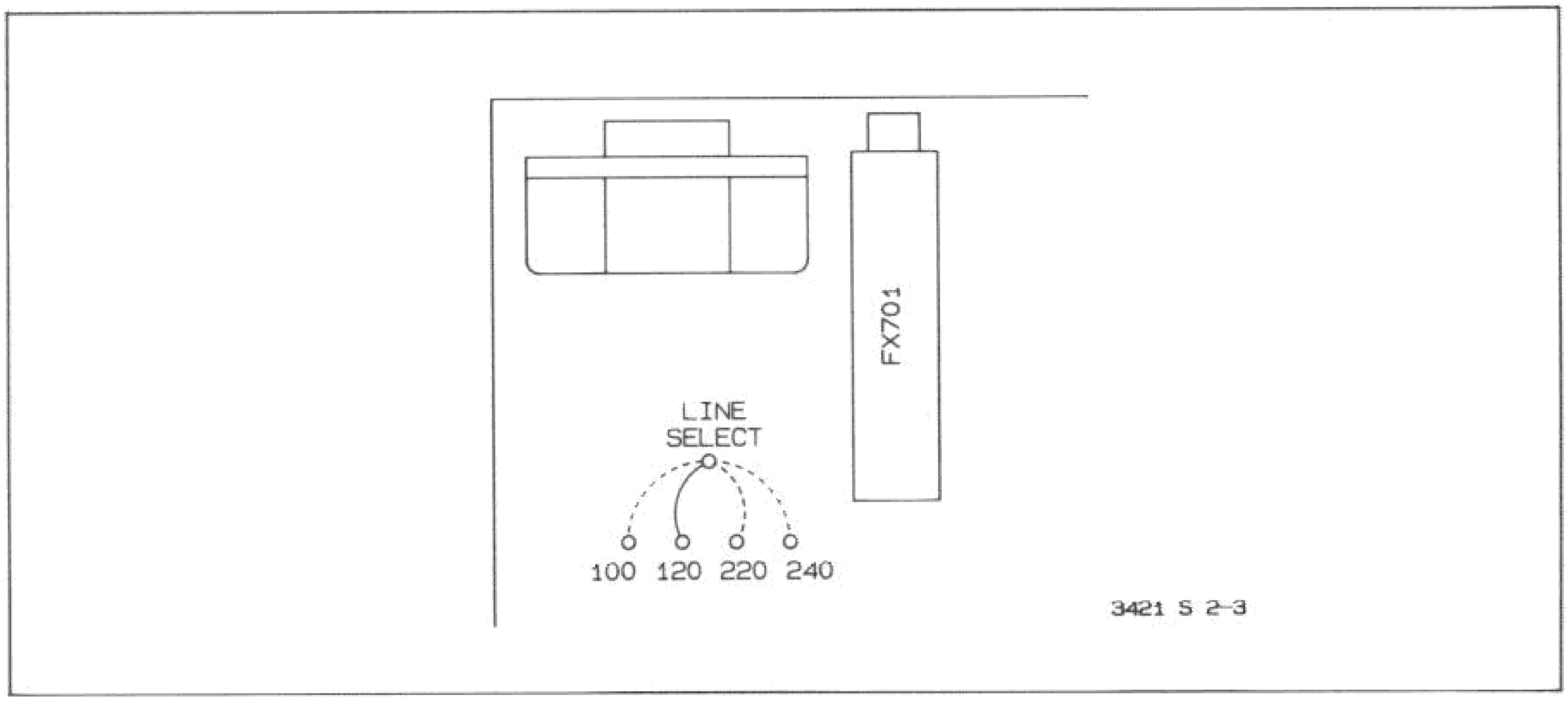



**Figure 1-2-3. AC Line Voltage Selection**

e. Make sure the wire is on the terminal that corresponds to the power line voltage in your area. If no, pull the wire off the terminal where it is located and place it on the proper terminal, as follows:

| Nominal Voltage | Use Terminal |
|---|---|
| 56-106 Volts | 100 |
| 104-127 Volts | 120 |
| 190-233 Volts | 220 |
| 208-250 Volts | 240 |

f. Re-install the top cover.

g. If the power line voltage jumper was changed, re-mark the rear panel to reflect the new configuration.

## 1-2-11. POWER CORDS AND RECEPTACLES

1-2-12. Figure 1-2-4 shows the various available power cord plugs for the HP 3421A. The HP part number for each plug (and cord) is shown directly below each illustration. If the inappropriate power cord is supplied with the instrument, notify the nearest HP Sales and Service Office and a replacement will be provided.

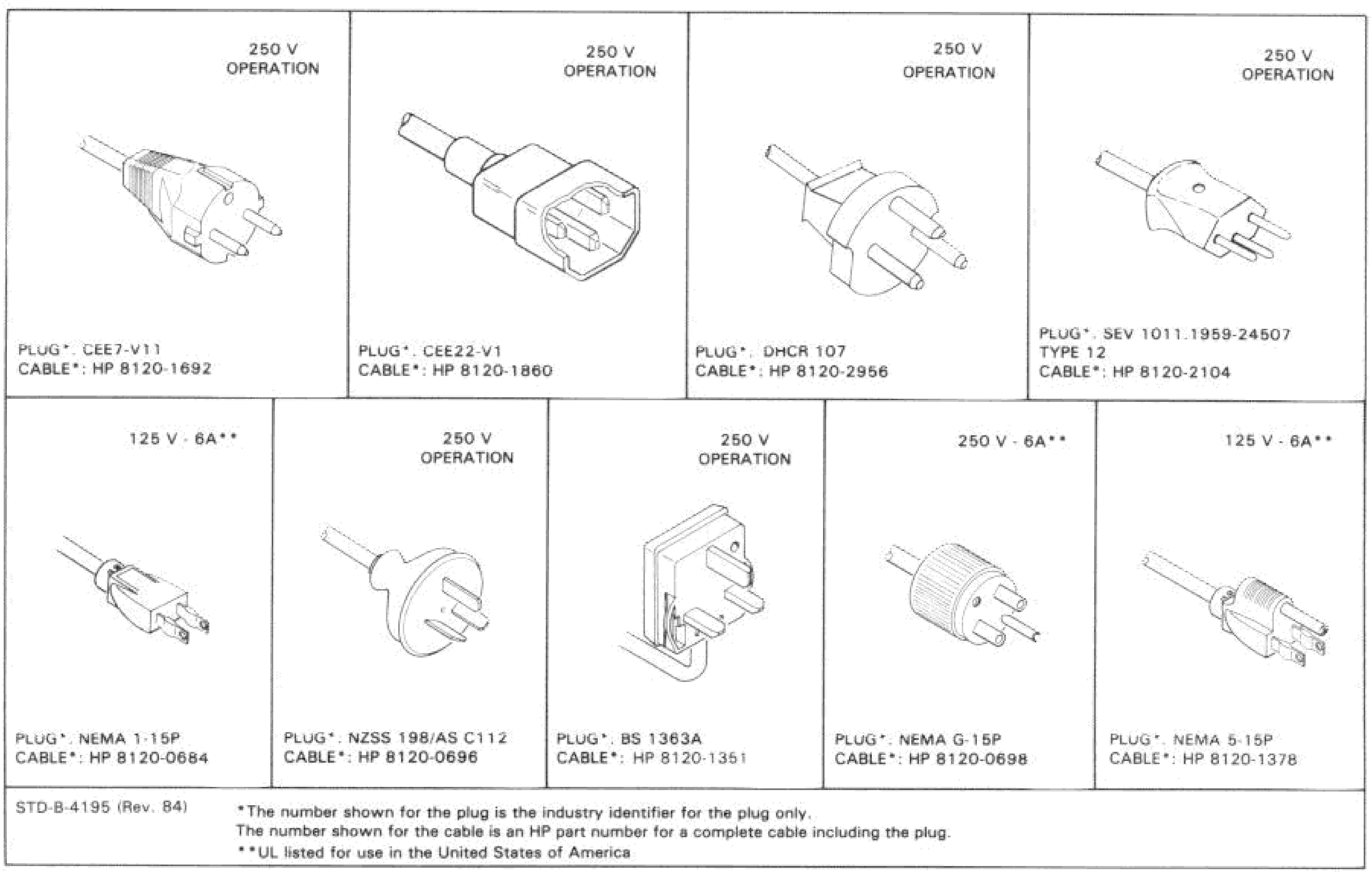



**Figure 1-2-4. Power Cables**

## 1-2-13. HP-IL INTERFACE CONNECTIONS

1-2-14. The standard I/O interface for the HP 3421A is the HP-IL (Hewlett-Packard Interface Loop). If your instrument is equipped with the optional HP-IB (Hewlett-Packard Interface Buss), refer to Chapter 4 (HP-IB Assembly Installation and Service Information) for an explanation on how to connect HP-IB cables.

1-2-15. A typical HP-IL interface connection is shown in Figure 1-2-5.

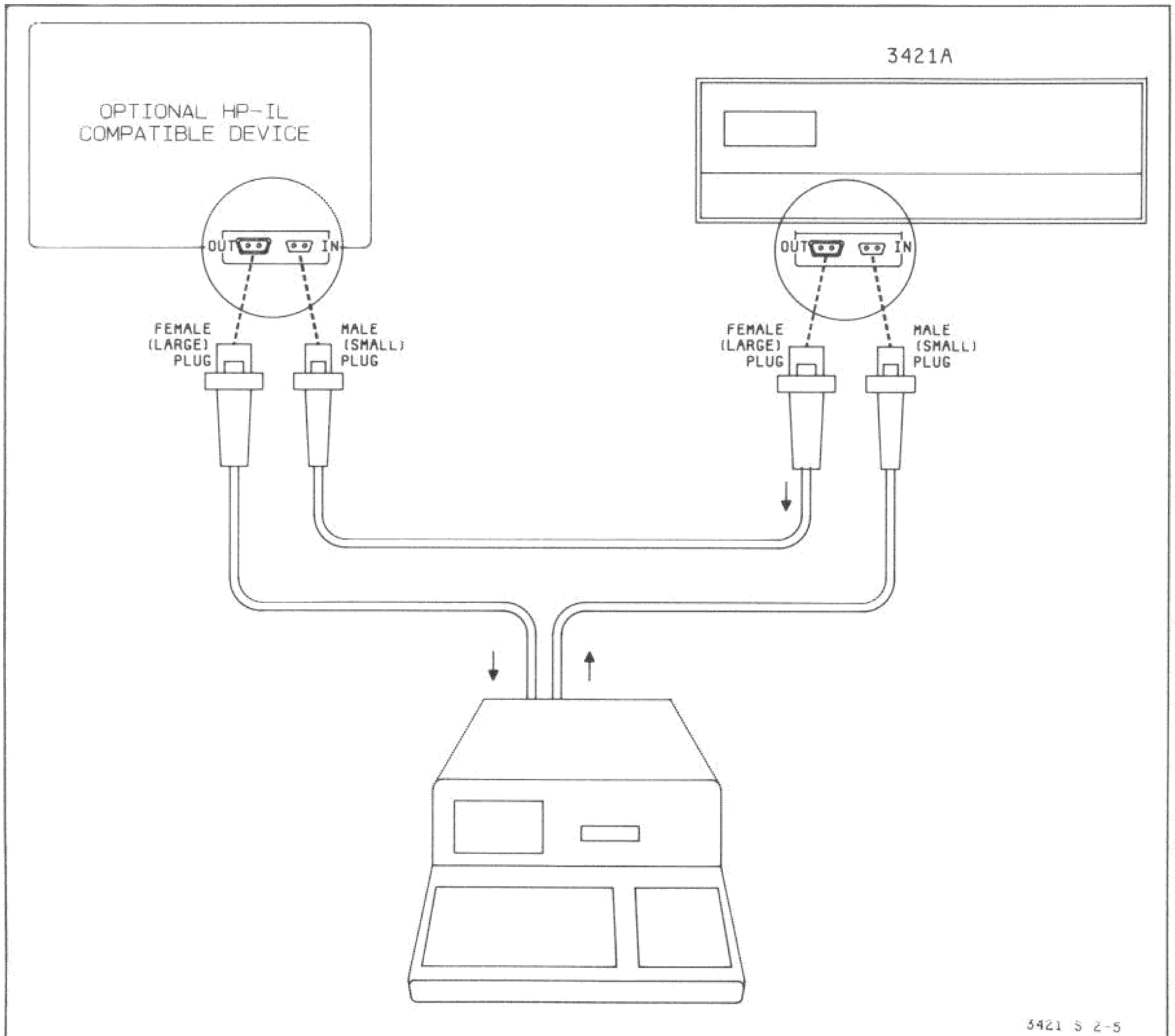



Figure 1-2-5. Typical HP-IL Interface Connection

## 1-2-16. OPTION BOARD CONNECTIONS

1-2-17. Typically, the HP 3421A will have one or more of the options listed in Section I. Installation and connection of these options is explained in the "Operating, Programming, and Configuration Manual".

## 1-2-18. ENVIRONMENTAL REQUIREMENTS

**WARNING**

*To prevent electrical fire or shock hazards, do not expose the instrument to rain or excessive moisture.*

### 1-2-19. Operating Temperature

1-2-20. To meet and maintain the specifications listed in Table 1-1-1, the HP 3421A should be operated within ±5°C (±9°F) of the reference temperature. The reference temperature is the temperature at which the HP 3421A was calibrated. For example, if the HP 3421A was calibrated at a temperature of 23°C (73°F), it should maintain its specifications if operated within ±5°C (±9°F) of that reference temperature. When the instrument is calibrated at the factory, the reference temperature is from 18°C to 28°C (64°F to 84°F). The HP 3421A can be operated within an ambient temperature range of 0°C to 55°C (32°F to 131°F), but it will have less accuracy if it is operated more than 5°C from the temperature at which it was calibrated.

### 1-2-21. Storage Temperature

1-2-22. The HP 3421A storage temperature must be between -40°C and +65°C (-40°F to +149°F).

## 1-2-23. REPACKAGING FOR SHIPMENT

**NOTE**

*If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be made. Also include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number. If you have any questions, contact your nearest HP Sales and Service Office.*

1-2-24. Place the instrument in its original container with appropriate packaging material and secure with strong tape or a metal band. If the original container is not available, a replacement can be purchased from your nearest HP Sales and Service Office. Hewlett-Packard suggests that you always insure shipments.

1-2-25. If the original container is not to be used, do the following:

a. Wrap the instrument in heavy plastic and then place it in an inner container.

b. Place packing material around all sides of the instrument and then seal the inner container with strong tape.

c. Place the inner container in a heavy carton and seal it with strong tape or metal bands.

d. Mark the shipping carton "DELICATE INSTRUMENT", "FRAGILE", etc..

## 1-2-26. WHERE TO SHIP YOUR HP 3421A FOR REPAIR

1-2-27. Return your unit to the nearest HP Sales and Service Office. A list of these offices is given at the end of this manual.

# SECTION III
# OPERATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 1-3-1. INTRODUCTION

1-3-2. This section contains the operating information for the HP 3421A. This information is abbreviated and is provided for service trained individuals, rather than operators. For complete operating instructions, refer to the HP 3421A Operating, Programming, and Configuration Manual.

## 1-3-3. GENERAL INFORMATION

### 1-3-4. AC Power Operation

1-3-5. Before connecting the HP 3421A to the ac power line, make sure it is configured to operate at the line voltage and frequency of your area. The instrument line voltage configuration is marked on the rear panel label. If your instrument is not configured for the power source you intend to use, refer to Section II of this chapter (Chapter 1) and re-configure the instrument.

### 1-3-6. Battery Operation

1-3-7. The instrument can be operated from its internal battery up to 12 hours when HP-IL is the interface standard or for six hours if HP-IB is the standard, assuming a fully charged battery before portable operation. If the battery is low (<5.8V) when the Model 3421A is turned on, the instrument displays ERROR 27 and then goes into a power down state (Model 3421A is inoperative) in approximately three seconds. If the battery goes below 5.8V during operation, the ERROR indicator turns on and the instrument goes into the power down state in approximately three minutes, after detecting the low battery. During the power down state, the instrument is completely inoperative, except for the display. If the power down state is enabled at turn on, the power indicator and ERROR 27 remain displayed. If the state is enabled during instrument operation, both the power and error indicators, and the previously closed channels will remain displayed. The battery is charged automatically when ac power is connected to the HP 3421A. A discharged battery that is between 1V and 5.8V can take up to 16 hours to fully charge with the front panel switch off. When the switch is on, it takes about 21 hours if the Model 3421A has HP-IL and longer if equipped with HP-IB. A fully discharged battery (<1V) can take up to 48 hours to charge.

**NOTE**

*On older HP 3421A's with serial numbers 2338A03052 and below or A1 Assemblies with an ERC of 2334 and below, the display turns off when the Model 3421A goes into the low power state.*

### 1-3-8. Turn On

1-3-9. When the front panel switch is pressed on (in), the instrument first checks for a low battery. If the battery is good, the instrument performs an eight segment self test. The self test results can be observed by watching the front panel display as the switch is pressed on. At turn on, the following sequence takes place. All display segments turn on for about one second followed by the display going blank, except for the power-on indicator. If the HP-IB option (Option 201) is installed and the HP-IB operation is selected, the HP 3421A displays the current HP-IB address for about one second, before the display goes blank. If a self test fails, the following takes place. The self test segment that fails (e.g., 0, 1, 2, etc.) is displayed about one second before the display goes blank (or before the HP-IB address is displayed). After the segment is displayed, the error indicator turns on and remains on. The error indicators, corresponding self test failures, and the corresponding bit set in the Hardware Error Register (see paragraph 1-3-43) are listed in Table 1-3-1. An explanation of the Hardware Error Register and possible causes of the self test failures are given in Table 1-3-2.

1-3-10. Immediately after the time allocated for the display of self test failures, the HP-IB address is displayed (if the HP-IB option is installed). Do not confuse an HP-IB address with a self test failure. Self test failures are indicated by display segments 0 thru 7 and will cause the error indicator to remain in the display. The HP-IB address can be indicated by any of the display segments, depending upon the HP-IB address that is set. If a low battery is detected at power on, display segment 27 will turn on, followed by an automatic instrument power down about three seconds later.

Table 1-3-1. Self Test Segments and Failures

| Self Test Segment | Description | Bit(s) Set SR #3 |
|---|---|---|
| 0 | Cal RAM Check Sum (U502) | 0 |
| 1 | ROM 1 Check Sum (U505) | 1 |
| 2 | ROM 0 Check Sum (U506) | 2 |
| 3 | A/D Slope Test | 3 |
| 4 | CPU RAM Check | 4 |
| 5 | RAM Check (U504) | 5 |
| 6 | RAM Check (U503) | 6 |
| 7* | 10 Mohm Test | 7 |

*Test Segment 7 checks for a 10 Mohm (± 20%) input resistance. If during the self test there are any connections on the front panel terminals or HI COMMON and LO COMMON of an installed Multiplexer Assembly, the test segment will probably fail. To ensure proper circuitry operation, make sure these inputs have been disconnected before running self test.

### 1-3-11. Turn On Configuration

1-3-12. At turn on after the HP 3421A goes thru its self test, it then takes on the following configuration.

a. Opens all scanner and actuator channels on any Multiplexer/Actuator Assemblies installed.

b. Clears all digital channels on any Digital I/O Assemblies installed.

c. Set the DC Volts function.

d. Turns on Autozero and Autorange (starts at 300 V range).

e. Sets the 5 Digit resolution.

f. Sets internal trigger on.

g. Initializes the Channel List to all available scanner channels, from the least significant to the most significant.

h. Checks the rear panel DIP switch settings and:

1. Sets Register 5 in the SRQ Mask (see paragraph 1-3-42) to decimal 84 or 86, dependent on the DIP switch #3 position.

2. Selects either 50 Hz or 60 Hz integration time for the A/D operation, dependent on DIP switch #5 position.

3. Sets bit 7 (CAL Enabled) in Register 19 (Voltmeter Status) of the Read State Register (see paragraph 1-3-45) if DIP switch #8 is down.

i. Request service (SRQ) if self test failed or at power on (if DIP switch #3 is in the up position).

### 1-3-13. Controller Interfacing

1-3-14. The standard HP 3421A is equipped with the Hewlett-Packard Interface Loop (HP-IL) Interface. The Hewlett-Packard Interface Bus (HP-IB) Interface is available as an option. Any controller can be used that supports HP-IL (or HP-IB if the instrument is so equipped). The operating information given in this section is for the HP-85 Computer. If you are using another computer, the programming examples may have to be modified.

### 1-3-15. Information Transfers

1-3-16. When operating with HP-IL, most HP 3421A commands will "hold-up" the computer until all readings have been taken. For example, suppose you have three Multiplexer/Actuator Assemblies installed and you program the HP 3421A to take 30 readings (one reading from each channel). With a reading rate of about two per second, 15 seconds are required to take all 30 readings. The computer can not perform any task while the HP 3421A is making the measurements.

1-3-17. Commands that do not hold-up the computer are: digital monitor commands MN, MH, and ML; TOTalize function; and Digital Trigger (DT).

1-3-18. With the HP-IB option installed, a switch on the option enables and disables buffered transfers. This switch is factory preset to disable buffered transfers (switch up). In the up position, the HP-IB interface acts much the same as the HP-IL interface, holding up program execution until all measurements initiated by a command have been made. With the switch down, buffered command transfers are enabled. This releases the computer while the HP 3421A is taking measurements, but does not release the HP-IB for further communication until the measurement is complete.

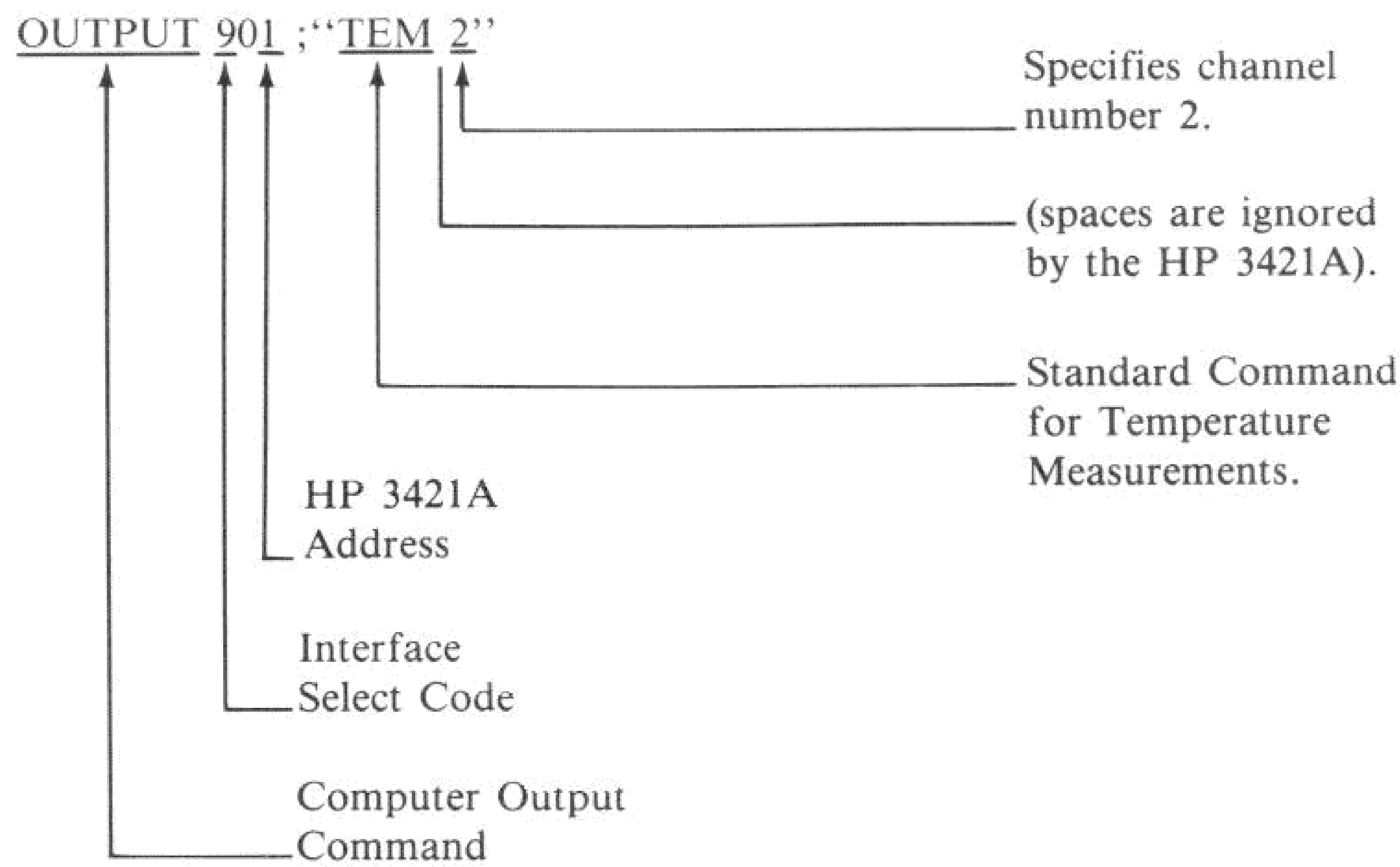
1-3-19. There are some HP-IL and HP-IB characteristics that should be understood. When using a digital monitor mode (MN, MH, ML, or DT), any communication through the interface (HP-IB or HP-IL) aborts the mode. For example, if the Model 3421A is waiting for a Digital Trigger (DT) and the computer or some other instrument sends any command or data through the interface, the HP 3421A aborts the Digital Monitor mode. It must be reprogrammed for that mode in order to re-enable the function.

1-3-20. When the HP-IB option is installed and one of the Digital Monitor modes (MN, MH, ML, or DT) is configured, the HP 3421A must be set to unlisten. This allows the HP 3421A to interrupt the computer by pulling the SRQ line when the interrupt causing event occurs. For the HP-85, this is done by the following program line, assuming the interface is on select code 7.

```
SEND 7 ; UNL
```

### 1-3-21. Addressing

1-3-22. Each instrument connected to the computer interface, whether it is HP-IL or HP-IB, has a unique address. The address provides the computer with a means of specifying a particular instrument that will send or receive data. Instructions such as OUTPUT 901 (for HP-IL) or OUTPUT 709 (for HP-IB) are examples of how the address is specified. The three digit number 901 specifies the device being selected is on interface select code 9 with an HP-IL address of 1. The number 709 specifies the device being selected is on interface select code 7 with an HP-IB address of 9. The following example shows how a typical OUTPUT statement is sent, and the purpose of the various portions of the statement.




**1-3-23. HP-IL Addressing.** The controller automatically reassigns addresses to each device connected in the loop. This is called "autoaddressing". Addresses are assigned sequentially around the loop in the direction of information flow. The first device in the loop after the controller is assigned address "1", the second device is assigned address "2", and so on. A maximum of 31 devices, including the controller, may be connected in the loop. The HP 3421A, regardless of where it is connected in the loop, will be autoaddressed accordingly.

**1-3-24. HP-IB Addressing.** When the HP 3421A has the HP-IB option installed, a switch on the option permits either HP-IB or HP-IL interfacing. When the HP-IB interface is selected, the HP-IB address is set by switches. These switches are factory preset for an HP-IB address of "9".

### 1-3-25. Sending Instructions to the HP 3421A

1-3-26. Commands sent to the HP 3421A instruct it to perform some specified task. At the end of this section is a quick reference guide which lists all commands the HP 3421A will respond to. Commands fall into two categories: standard and advanced.

a. Standard commands set up the HP 3421A and complete a measurement task. For example, the command DCV2,7-9 causes the HP 3421A to take dc voltage measurements on channels 2, 7, 8, and 9, and store the readings in its internal memory. One command causes a complete measurement task to be performed.

b. Advanced Commands provide additional flexibility, but they do not perform a complete measurement task. These commands perform only one aspect of a measurement. Advanced commands are suitable for those who wish to tailor their system for some particular requirement.

### 1-3-27. Channel List Rules

1-3-28. The channel list specifies the order in which channels will be measured. The series of channels specified must adhere to the following rules.

a. The default channel list (asserted at power on or reset) consists of all multiplexer channels in numerical sequence. The channel list can be loaded with multiplexer channels by the DCV, ACV, TWO, FWO, TEM, FRQ, LS or LP commands. It can also be loaded with digital input bit numbers by the BIT command.

b. Channel addresses are separated by commas. However, a dash may be used to signify a contiguous set of channels. When using Advanced Commands, any command that specifies a channel must be separated from subsequent commands by either a colon (:) or a semicolon (;) but not a comma (,). Example: F1RA1Z1N5LS5-9;T3. If the last character in the command string is a comma, an error will be generated.

c. No more than 30 channels are accepted into the channel list. Legal channel numbers are 00 through 29.

d. The mnemonic determines what type of channel can be loaded into the channel list. In other words, if channel 1 is configured as an actuator channel, it should not be specified for any type of measurement (i.e., DCV1 or BIT1). If an attempt is made to load the channel list with an improper type of channel, a syntax error is generated and the command is aborted. If channels x-y are received and some channels in between and including x and y are the wrong type of channels for the command, they are not loaded into the list and the error message is not sent. The remainder of the channels are loaded into the list.

e. Leading zeros are ignored. Example: DCV00019 means DCV19.

f. All syntax following a decimal point is ignored except for comma (,), dash (-), semicolon (;), colon (:), carriage return (CR), or line feed (LF). Example: DCV2.3 means DCV2.

g. Exponents are not allowed and cause a syntax error. The command is also aborted.

h. All lower case letters are interpreted as upper case. Blanks and plus signs (+) are ignored. For example, Dc V+21 is the same as DCV21.

i. Terminators are required after any command (standard or advanced) that either specifies a channel or a decimal value, when that command is to be followed by another command. For example, the 'Mx' command is used to set the SRQ mask. This command can have a decimal integer value 'x' of between 0 and 255. Therefore, this command must be followed by a terminator if another command is to follow it. Example: OUTPUT 901 ; "M1;T0". Valid terminators are a colon (:), semicolon (;), carriage return (CR) or line feed (LF).

### 1-3-29. Receiving Data from the HP 3421A

1-3-30. The HP 3421A can "talk" to the computer or other instruments. For this to occur, however, the computer must address the HP 3421A to talk. For example, suppose you want to take a temperature measurement on channel 2, and have the HP 3421A send the information to the computer. Using the HP-85 equipped with an HP-IL interface on select code 9, you can do this by executing the following program.

```
10 OUTPUT 901 ; "TEM2"
20 ENTER 901 ; A
30 DISP A
40 END
```

1-3-31. The ENTER 901 statement addresses the HP 3421A to talk. The measured temperature is stored in the variable A. The DISP A statement causes the computer to display the temperature measured. Computer syntax statements (OUTPUT, ENTER, DISP, etc.) are computer dependent, and may be different for different computers.

### 1-3-32. HP 3421A Output Formats

1-3-33. Measurement data is sent by the HP 3421A as 13 bytes in the following format (5 ½ digit mode).

| | |
|---|---|
| Measurement: | ± d.ddddE ± CR LF |
| Error: | − 8.88888E + 8 CR LF |
| Overload: | + 9.99999E + 9 CR LF |

(Note: Many computers change the 13 bytes to an actual reading like changing − 8.88888E + 8 to − 888888000.)

1-3-34. Digital data is sent by the HP 3421A as follows:

| | |
|---|---|
| Digital: | ddd CR LF |
| Digital Error: | 888 CR LF |

1-3-35. Notice that measurement data is sent in exponential form. The exponent is the same as the voltmeter range unless the measurement is temperature or frequency. In other words, the reading + 1.23456E − 1 means the reading is on the .3V range (R − 1), and the measured value is .123456V. When the measurement is entered into a numeric variable (e.g., A), the measurement will be adjusted to eliminate the exponent. The number of digits following a decimal point is the same as the number of digit resolution configured. This means that if 3 digit resolution is configured (N3), the reading will be output as: ± d.dddE ± . This change of output digits is also true for errors. The computer may not display trailing 0's, depending upon how it is configured.

**1-3-36. Error Format.** As previously noted, the error format for the 5 ½ digit mode is −8.88888E+8, and changes for the digit resolution configured. The error message is sent in place of the first reading after the error occurs. Bit 5 of the status register will also set. Conditions that will cause the error message are:

a. Hardware error.
b. Calibration error.
c. Command syntax not understood.
d. Can't execute command.
e. Low battery.
f. Self Test failed.

1-3-37. The error message is not sent if the status byte is read (SPOLL or SR commands) before the HP 3421A is addressed to talk. In this case, the reading will be sent if it is available. The reading will not be available if:

a. No measurement has been taken.
b. Function F0 is asserted and the HP 3421A is triggered.
c. If the channel list and bit list are empty and the HP 3421A is triggered by T3, DT, or TRIGGER.

1-3-38. If an error occurred during a digital read, the error message is 888.

**1-3-39. Overload Format.** There are two conditions that causes the overload message (+9.99999E+9) to be sent. These are:

a. Voltmeter overload.
b. Counter overflow in TOTalize mode (greater than 65535 counts).

### 1-3-40. Require Service (SRQ)

1-3-41. The HP 3421A can interrupt the computer for certain conditions if it is programmed to do so. How the computer responds to the interrupt depends upon how it is programmed. Here is a list of the conditions that can be programmed to cause the interrupt:

**a. Power-on/Reset.** The HP 3421A will interrupt the computer at power on, the HP 3421A receives a Device CLEAR or Selected Device CLEAR, or the HP 3421A is reset (RS). The HP 3421A rear panel switch segment 3 must be set to the up position for this interrupt to occur.

**b. Data Ready.** The HP 3421A will interrupt the computer after each completed measurement or, if a channel list is measured, the interrupt will occur after all readings are taken.

**c. Self Test Error.** If any of the eight self tests fail, an interrupt will occur.

**d. Event Occurred.** The HP 3421A can monitor the digital input ports and, if a specified bit or 8-bit word occurs, it will send an interrupt.

**e. Low Battery.** If the HP 3421A is being powered by its internal battery, it will generate an interrupt when the battery drops below 5.8V. Then, after approximately three minutes, the HP 3421A will power down. When a low battery is detected, the following commands cannot be executed: TOT, MH, ML, MN.

f. **Abnormal Condition.** Abnormal conditions include:

1. Hardware error.
2. Calibration error - calibration is suspect.
3. Command from computer not understood - e.g., FR3 is not a legitimate command for the HP 3421A.
4. Can't execute a command - e.g., a command to close channel 25 with no multiplexer in slot 2.
5. Low battery.
6. Self test failed.

### 1-3-42. Status Register and Status Byte

3-43. The status register indicates several different operating conditions of the HP 3421A. The status register is updated as events occur. If the SRQ mask is set for a particular condition and that condition occurs, an interrupt will be sent to the computer. The status register is shown in Figure 1-3-1.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| always zero | Require Service (no mask) | Abnormal Condition | Low Battery (not maskable) | Event Occurred | Self Test Error (not maskable) | Power-on Reset (switch mask only) | Data Ready |

**Figure 1-3-1. Status Registers**

1-3-44. The status byte is an 8-bit byte that is sent from the HP 3421A to the computer in response to the SPOLL message. The status byte is derived from the status register and is used to determine the current status of the HP 3421A. The status byte is sent to the computer in decimal. Thus, bit 0 has a weight of 1, bit 1 a weight of 2, bit 3 a weight of 4, etc..

### 1-3-45. Read State Registers

1-3-46. There are 24 registers that can be read with the "SR" command to determine the exact status of the HP 3421A. Registers 1 thru 4 are shown in Figure 1-3-2 and are the status, error, hardware error, and calibration error registers. These registers can be used to determine the error state of the instrument. An explanation of Registers 3 and 4 and possible causes of the errors in these registers are given in Table 1-3-2. Registers 1 thru 4 are cleared when they are read; the others are not. Register 5 is used to determine the status of the SRQ mask and the rest of the registers (6 thru 24) are used to determine the current state of the instrument (i.e., which options are available in the instrument, the current measurement function, etc.). Registers 5 thru 24 are shown in Figure 1-3-3. When reading any register, the value returned for each register is a decimal value equal to the sum of the values of the bits set in the registers. Use the following programs to read the registers (assuming that the HP 3421A is at HP-IL address 901).

a. To read the Registers 1 thru 4, use this program:

```
10 OUTPUT 901 ; "SR"
20 FOR I=1 TO 4
30 ENTER 901 ; A
40 A$=DTB$(A)
50 DISP A$[9]
60 NEXT I
70 END
```

b. To read all the registers, use this program:

```
10 DIM A(24)
20 OUTPUT 901 ; "SR"
30 FOR I=1 TO 24
40 ENTER 901 ; A(I)
50 DISP A(I)
60 NEXT I
70 END
```

**Register 1:** Status Register

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Always 0 | SRQ | Abnormal Condition | Low Battery | Event Occured | Self Test Error | Power-On Reset | Data Ready |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Value

**Register 2:** Error Register

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Tried to load channel list with more than 30 channels | Can't do T3 since channel list is empty | Can't do TOT,MH, ML,MN,DT while battery is low | Option specified in command does not exist in that slot | Invalid Syntax | No data ready but addressed to talk | Triggered but F0 asserted |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Value

**Register 3:** Hardware Error Register

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| 10 Mohm test failed | RAM U503 failed | RAM U504 failed | uP RAM failed | A/D Slope Error | ROM0 checksum Error | ROM1 checksum Error | Cal RAM checksum Error |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Value

**Register 4:** Calibration Error Register

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | A/D Error | Cal RAM defective | Calibra-tion attempted but not enabled | Invalid Cal zero | Invalid Cal signal | Invalid Cal number | Invalid Cal function or range |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Value

**Figure 1-3-2. Status, Error, Hardware Error, and Cal Error Registers**

**Table 1-3-2. Registers 3 and 4 Description**

| Register | Bit # | Description |
|---|---|---|
| 3 | 0 | Cal RAM Checksum Error.<br>This shows if any calibration RAM locations have incorrect checksums which can be caused if one or more calibration constants are missing or are invalid. If the bit is set in self test, it is typically caused by an uncalibrated Multiplexer/Actuator option. Perform the temperature calibration procedure for each option installed, as given in paragraph 1-4-59. If the bit is set when attempting the temperature calibration of the Multiplexer/Actuator option, continue with the calibration procedure. If, after calibration, the bit is still set, perform a complete instrument calibration. If after a complete calibration the bit is still set, go to Section VIII for troubleshooting. |
| | 1 | ROM1 Checksum Error.<br>This shows a ROM1 (U505) checksum error. The most likely cause is a hardware failure of the ROM itself. Go to Section VIII for troubleshooting. |
| | 2 | ROM0 Checksum Error.<br>This shows a ROM0 (U506) checksum error. The most likely cause is a hardware failure of the ROM itself. Go to Section VIII for troubleshooting. |
| | 3 | A/D Slope Error.<br>This shows an A/D slope error which can be caused by the A/D Converter itself, by an inoperative reference voltage circuitry, or the input circuitry (i.e., U102, U101, or associated circuitry). This failure could also cause bit 7 to set. Go to Section VIII for troubleshooting. |
| | 4 | Microprocessor RAM Failed.<br>This bit is set, if the RAM in the CPU (U508) is defective. Go to Section VIII for troubleshooting. |
| | 5 | RAM U504 Failed.<br>This bit is set if RAM U504 is defective. Go to Section VIII for troubleshooting. |
| | 6 | RAM U503 Failed.<br>This bit is set if RAM U503 is defective. Go to Section VIII for troubleshooting. |
| | 7 | 10 Mohm Test Failed.<br>This indicates that the 100:1 Divider (i.e., the 9.9M and 100K ohm resistors in U102) may be defective. This divider is only used on the 30V and 300V ranges. Since, during self test or at turn on, any external connections to the HP 3421A makes the divider test fail, make sure no external connections are made to the HP 3421A at turn on or while the self test is enabled. If the bit is still set with no external connections, suspect a defective U102. This bit may also be set if any part of the analog measurement circuitry to the 100:1 Divider is defective. This bit will probably be set if bit 3 (A/D Slope Error) is also set. If both bits 3 and 7 are set, the failure is most likely in the A/D Converter circuitry (go to Section VIII for troubleshooting). |

**Table 1-3-2. Registers 3 and 4 Description (Cont'd)**

| Register | Bit # | Description |
|---|---|---|
| 4 | 0 | Invalid Cal Function or Range.<br>This bit is set if the calibration constants cannot be calculated in the selected function and range. For example, If F0 (all functions off) is selected, or R-1 (.3V range) is selected with the HP 3421A in the F2 (ac volts) function, the bit will be set. Make sure the correct function and range combination is selected before attempting any calibration. |
| | 1 | Invalid Cal Number.<br>This shows that an attempt was made to calibrate the HP 3421A with an incorrect calibration number. For example, if the number for the full scale calibration signal is NOT between 299000 and 301000 or 099000 and 101000 for the ⅓ scale calibration signal, the bit will be set. Make sure the calibration signal and number are at the correct values before attempting any calibration. |
| | 2 | Invalid Cal Signal.<br>This bit is set if an attempt is made to calibrate a function and range using the wrong calibration signal. For example, the bit is set if a dc volts signal is used to calibrate the ohms function. This bit can also be set when doing the temperature calibration of the Multiplexer/Actuator option. This can happen if the HP 3421A is unable to receive a valid signal from the temperature transducer on the option. If the bit is set during temperature calibration, make sure the option's cables, associated temperature transducer, or U102 in the HP 3421A mainframe are good. If the HP 3421A has an older A1 Assembly with HP Part Number 03421-66501, suspect the temperature sensor FETs in U102. |
| | 3 | Invalid Cal Zero.<br>This shows that the zero calibration constant is invalid when attempting to calibrate at full or ⅓ scale. Make sure the correct zero calibration has been performed before doing any full or 1/3 scale calibration. |
| | 4 | Calibration Attempted But Not Enabled.<br>This shows that an attempt was made to calibrate the HP 3421A with the calibration enable switch set in the disable position (S501 segment #8 in the up position). Make sure the switch is set in the calibration enable position (down) before performing any calibration. |
| | 5 | Cal RAM Defective.<br>This shows a defective calibration RAM (U502). Go to Section VIII for troubleshooting. |
| | 6 | A/D Error.<br>This bit is only set when an A/D error shows up during calibration. It can be caused by the A/D Converter itself, an inoperative reference voltage circuitry, or the input circuitry (.i.e., U102, U101, or associated circuitry). Go to Section VIII for troubleshooting. |
| | 7 | This bit is not defined and can be either 1 or 0. |

## Register 5: Status of the SRQ Mask (see SPOLL in Chapter 3)

| Bit 7 | Bit 6* | Bit 5 | Bit 4* | Bit 3 | Bit 2* | Bit 1** | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | SRQ (always 1) | 1 = SRQ if abnormal condition occurs | Low battery (always 1) | 1 = SRQ if event occurs (MN,ML,MH DT) | Self Test failed (always 1) | 1 = SRQ if Power-on reset occurs | 1 = SRQ if data ready |

* The bits labeled as "always 1" are not maskable. When the event occurs, the SRQ interrupt message will be sent to the controller.

** This bit or feature is enabled/disabled by the POWER-ON SRQ switch on the HP 3421A rear panel (switch S501, segment #3).

## Register 6: Option Boards Available

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Slot 2 is digital option | Slot 1 is digital option | Slot 0 is digital option | Always 0 | Slot 2 is MUX option | Slot 1 is MUX option | Slot 0 is MUX option |

## Register 7: Actuator Channels Available

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = actuator channel 21 | 1 = actuator channel 20 | 1 = actuator channel 11 | 1 = actuator channel 10 | 1 = actuator channel 01 | 1 = actuator channel 00 |

## Register 8: Actuator Channels Closed

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = actuator channel 21 closed | 1 = actuator channel 20 closed | 1 = actuator channel 11 closed | 1 = actuator channel 10 closed | 1 = acutator channel 01 closed | 1 = actuator channel 00 closed |

**Registers 9 and 10:** Register 9 contains the channel address when a multiplexer channel is closed. If channel pairs were closed, Register 10 contains the paired channel.

| Bit 7 Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | | | | | | | |
| Slot 0: | 0 | 0 | 0 | 0 | 0 | 0 | :Channel 0 |
| Slot 1: | 0 | 1 | 0 | 0 | 0 | 1 | :Channel 1 |
| Slot 2: | 1 | 0 | 0 | 0 | 1 | 0 | :Channel 2 |
| | | | 0 | 0 | 1 | 1 | :Channel 3 |
| | | | 0 | 1 | 0 | 0 | :Channel 4 |
| | | | 0 | 1 | 0 | 1 | :Channel 5 |
| | | | 0 | 1 | 1 | 0 | :Channel 6 |
| | | | 0 | 1 | 1 | 1 | :Channel 7 |
| | | | 1 | 0 | 0 | 0 | :Channel 8 |
| | | | 1 | 0 | 0 | 1 | :Channel 9 |
| | X | X | 1 | 1 | 1 | 1 | :no channel closed |

Bit definition for Registers 9 and 10 are the same.

**Figure 1-3-3. Read State Registers**

Registers 11 through 16: Indicates which relay channels were closed by the UC command.

Register 11

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = chan 4 closed | 1 = chan 3 closed | 1 = chan 2 closed | 1 = chan 1 closed | 1 = chan 0 closed |

Register 12

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = chan 9 closed | 1 = chan 8 closed | 1 = chan 7 closed | 1 = chan 6 closed | 1 = chan 5 closed |

Register 13

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = chan 14 closed | 1 = chan 13 closed | 1 = chan 12 closed | 1 = chan 11 closed | 1 = chan 10 closed |

Register 14

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = chan 19 closed | 1 = chan 18 losed | 1 = chan 17 closed | 1 = chan 16 closed | 1 = chan 15 closed |

Register 15

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = chan 24 closed | 1 = chan 23 closed | 1 = chan 22 closed | 1 = chan 21 closed | 1 = chan 20 closed |

Register 16

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = chan 29 closed | 1 = chan 28 closed | 1 = chan 27 closed | 1 = chan 26 closed | 1 = chan 25 closed |

**Figure 1-3-3. Read State Registers (Cont'd)**

## Register 17: Functions

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | | | |

| | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|
| No functions asserted: | 0 | 0 | 0 |
| DC Volts: | 0 | 0 | 1 |
| AC Volts: | 0 | 1 | 0 |
| 2-Wire Ohms: | 0 | 1 | 1 |
| 4-Wire Ohms: | 1 | 0 | 0 |
| Reference Temperature: | 1 | 0 | 1 |
| Tempererature (T-type thermocouple): | 1 | 1 | 0 |
| Frequency: | 1 | 1 | 1 |

## Register 18: Ranges

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | | | | | | |

Counter Gate Time Codes:

| | Bit 5 | Bit 4 |
|---|---|---|
| .1 Second | 0 | 0 |
| 1 Second | 0 | 0 |
| 10 Second | 1 | 1 |

Voltmeter Range Codes:

| Bit 3 | Bit 2 | Bit 1 | Bit 0 | |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | - NOT USED |
| 0 | 0 | 0 | 1 | - R-1 |
| 0 | 0 | 1 | 0 | - R0 |
| 0 | 0 | 1 | 1 | - R1 |
| 0 | 1 | 0 | 0 | - R2 |
| 0 | 1 | 0 | 1 | - R3 |
| 0 | 1 | 1 | 0 | - R4 |
| 0 | 1 | 1 | 1 | - R5 |
| 1 | 0 | 0 | 0 | - R6 |
| 1 | 0 | 0 | 1 | - R7 |

## Register 19: Voltmeter status

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| 1 = Cal enabled | Not Defined May be 1 or 0 | | | 1 = 50Hz 0 = 60Hz integration time | 1 = auto-zero on 0 = auto zero off | 1 = auto-range on 0 = auto range off | 1 = internal trigger |

| Bit 5 | Bit 4 | |
|---|---|---|
| 0 | 0 | - T0 (Trigger hold) |
| 0 | 1 | - T1 |
| 1 | 0 | - T2 |
| 1 | 1 | - T3 |

## Register 20: Number of Digits of Resolution

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | | |

| | Bit 1 | Bit 0 |
|---|---|---|
| invalid: | 0 | 0 |
| 5½ digit res.: | 0 | 1 |
| 4½ digit res.: | 1 | 0 |
| 3½ digit res.: | 1 | 1 |

**Figure 1-3-3. Read State Registers (Cont'd)**

## Register 21: Channel List

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| 1 = channel list is digital bits. 0 = channel list is mux channels | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = TOT function on. | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 |

## Register 22: Display Mode

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 | 1 = DN mode on. 0 = DN mode off. | Not Defined May be 1 or 0 | Not Defined May be 1 or 0 |

## Register 23: AND mask (set by AN[abc] command)

## Register 24: Exclusive-OR Mask (set by XR[abc] command)

**Figure 1-3-3. Read State Registers (Cont'd)**

## HP 3421A Quick Reference Guide

The HP 3421A command set consists of standard commands and advanced commands. Each standard command performs a complete measurement or function while two or more advanced commands are generally required to perform a measurement. Refer to the blue pages in the center of the HP 3421A Operating, Programming, and Configuration Manual for more information and program examples on each command.

[ ] means optional channel or bit list
< > means mandatory channel or bit list

**Standard Commands**

**DCV [x,y,...z]** DC Volts. Sets the voltmeter to DCV (F1), Autorange (RA1), Autozero on (Z1), 5 1/2 digits resolution (N5). If no channel list is sent, the channel list is not changed but software single trigger is executed (T2). If channel list is sent, they are loaded in order received then a reading is made and stored from each channel in sequence (T3). DCV always opens the last channel before closing the next channel in the list. It exits with the last channel in the list closed unless no numbers were received then it exits with the channels in the same state they were in prior to the command. When the HP 3421A is addressed to talk, all readings will be sent in the sequence they were taken.

**ACV [x,y,...z]** Same as DCV but for AC Volts (F2) and 4 ½ digit resolution (N4).

**TWO [x,y,...z]** Same as for DCV but for 2-wire Ohms (F3) measurements.

**FWO [x,y,...z]** Same as for DCV except for 4-wire Ohms (F4) measurements. Channels are automatically paired with $x+10$, $y+10,\ldots z+10$ unless x,y,...z are between 20 and 29 in which case they are paired with $x-20$, $y-20,\ldots z-20$. Pairs are closed simultaneously.

**TEM [x,y,...z]** Same as for DCV but for temperature measurements (F6) and does a software compensated T-type thermocouple conversion. Result returned is in Degrees C. TEM will take a REF temperature measurement on the HP 44462A assembly in the lowest numbered slot if no channel numbers are sent.

**REF [x]** Measures the temperature of the REFerence junction (F5) on HP 44462A assembly where channel 'x' is. If 'x' is not sent, then defaults to assembly where a multiplexer channel is closed. If no channel is closed, then selects HP 44462A assembly in lowest numbered slot. Result returned in Degrees C.

**FRQ [x,y,...z]** Measures FReQuency (F7) with a 1 second gate time (G0), 5 ½ digits resolution (N5). If no channel numbers are sent, the channel list is not changed and no channels are opened or closed. A software single trigger (T2) is executed. If channel list is sent they are loaded in the order received and a reading is made and stored from each channel in sequence. When addressed to talk, all readings will be sent in the sequence they were taken.

**TOT [x]** TOTalizes events (F7) up to a maximum count of 65,535. If channel 'x' is sent, all channels will be opened before closing channel 'x'. The counter will be zeroed and then starts totalizing. If 'x' is not sent, then the counter is zeroed and starts totalizing without changing channels. Channel 'x' will remain closed until another command opens it. When the HP 3421A is addressed to talk, it will send out the current subtotal without disrupting the counter. NOTE: if a TRIGGER command is received, the TOT is aborted and a frequency reading is made.

**CLS <x>** CLose Single channel 'x'. The HP 3421A first identifies the type of channel at 'x' and then if 'x' is:

- an Actuator - closes channel x possible actuator channel numbers are: 00,01,10,11,20,21).
- a Digital Output Bit - closes it.
- a Multiplexer - opens all multiplexer relays and closes channel 'x'.

**CLP <x>** CLose a Pair of channels. The HP 3421A will open all multiplexer relays and then close channels x and $x+10$. If $x \geq 20$, then x and $x-20$ will be closed. If either x or its pair is not a multiplexer channel, then no channels are closed or opened and an error is generated.

**OPN[x]** Open channel(s). If channel 'x' is not sent, then the OPN command will open all channels digital outputs, actuators, and multiplexers. If 'x' is sent, the HP 3421A identifies the channels and if 'x' is:

- an Actuator - opens it.
- a Digital Output Bit - clears bit 'x'
- a Multiplexer - opens it. This includes channels closed by the UC command. If 'x' was closed as a pair (i.e., CLPx) then its pair will be opened also.

**REDi** REaDs the digital input byte from slot i and replies with a decimal number from 0 to 255. This decimal number represents the values of the bits that were set. Must be an integer value. No decimal points or extra digits allowed.

**WRTi,[ab]c** WRiTe the decimal value [ab]c to slot i. The value [ab]c $\leq 255$. If a and/or b not received then the HP 3421A assumes leading zeros. Must be an integer value. No decimal points or extra digits allowed.

**BIT <x>[,y,...z]** Reads the digital input bits (up to 30 in the bit list) and sends +0.000E+0 if the bit is low or +1.000E+01f the bit is high. Invalid bit numbers are 08,09,18,19,28, and 29. Also configures for 3-digit readings.

## HP 3421A Quick Reference Guide

**Advanced Commands**

| Function, Command | –1Range Codes (RA1 = Autorange on, RA0 = off) R-1 | R0 | R1 | R2 | R3 | R4 | R5 | R6 | R7 |
|---|---|---|---|---|---|---|---|---|---|
| All functions off, F0 | x | x | x | x | x | x | x | x | x |
| DC Volts, F1 | .3V | 3V | 30V | 300V | ← | ← | ← | ← | ← |
| AC Volts, F2 | → | 3V | 30V | ← | ← | ← | ← | ← | ← |
| 2-Wire Ohms, F3 | → | → | → | 300Ω | 3kΩ | 30kΩ | 300kΩ | 3MΩ | 30MΩ |
| 4-Wire Ohms, F4 | → | → | → | 300Ω | 3kΩ | 30kΩ | 300kΩ | 3MΩ | 30MΩ |
| REFerence, F5 | x | x | x | x | x | x | x | x | x |
| TEMperature, F6 | x | x | x | x | x | x | x | x | x |
| FReQuency, F7 | Gate time: G-1 = .1S, G0 = 1S, G1 = 10S | | | | | | | | |

Voltmeter Autzero: Z0 = Auto-zero off, Z1 = Auto-zero on.

Number of digits of resolution: N3 = 3 1/2, N4 = 4 1/2, N5 = 51/2

Trigger: T0 = Hold trigger and enable channel list scan
T1 = Internal trigger
T2 = Software single trigger
T3 = Triggers measurements from channel list and stores readings
DTa = Digital Trigger, does a T3 when digital input bit 'a' goes low.

AN[decimal value 0-255] ANd mask, used with MN command.

C[cal value] Calibrate, see calibration procedure.

DC[slot number, decimal integer value 0-255] Digital Clear specified output bits.

DS[slot number, decimal integer value 0-255] Digital Set specified output bits.

DN[number0-29] Display Number, note: send DN alone (with terminator) to turn off mode.

LS<channel list> Load Single channels into channel list.

LP<channel list> Load channel Pairs into channel list.

M[decimal integer number] Set SRQ Mask.

MH<digital bit> Monitor digital input bit and SRQ interrupt when bit goes high. Exponents illegal; ignores everything after decimal point.

ML<digital bit> Monitor digital input bit and SRQ interrupt when bit goes low. Exponents illegal; ignores everything after decimal point.

MN<slot number> Monitor slot and compare to AN mask and XR mask. SRQ interrupt when result = 0. Must be integer value.

RL Read channel List.

RS ReSet.

SI<0 or 1> SI0 = Initialize channel list pointer to beginning of list. SI1 = opens channel and closes next channel in list. Must be an integer value.

SR Read Status Registers.

UC<channel number> Unconditionally Close specified channel.

XR[decimal integer value 0-255] eXclusive-oR mask, used with the MN command.

# SECTION IV
# PERFORMANCE VERIFICATION AND CALIBRATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 1-4-1. INTRODUCTION

1-4-2. This section contains manual and semiautomated performance verification and calibration procedures for the HP 3421A. The manual performance verification is explained first, followed by the manual calibration procedure. The semiautomated procedures require the HP 3421A Calibration and Test Tape Cartridge (HP Part Number 03421-10001, Revision C or higher) and are described in paragraph 1-4-67 (towards the end of the section).

**NOTE**

*In the procedure, it is assumed that the interface select code is "9" and the device address is "01" (i.e., "901"). This is typical when using an HP-IL interface and the HP 3421A is the first device in the loop. The procedures can also be used with HP-IB if the proper interface select code and device address are specified (e.g., "709" in place of "901").*

### 1-4-3. RECOMMENDED EQUIPMENT

1-4-4. All recommended test equipment for the performance tests and calibration procedures is listed in Table 1-4-1. The equipment used for the individual tests and calibration procedures is also noted at the beginning of each procedure. Test equipment can be substituted if it meets the critical specifications listed.

4-5. The procedures assume that the computer I/O interface is set to select code "9". If the interface is HP-IB, the HP 3421A must have the HP-IB Option installed with the address switches set to "01". If the interface is HP-IL, the HP-85 will automatically assign address "01" to the HP 3421A if it is the first device in the loop. All commands in the procedures use address "901" (9 + 01).

**Table 1-4-1. Recommended Test Equipment**

| Instrument | Critical Specifications | Recommended Model | Use* |
|---|---|---|---|
| Digital Voltmeter | Range: .3V to 300V<br>Accuracy:<br>±.004%(30V,300V)<br>±.005%(.3V,3V)<br>Temperature Math Function<br>Accuracy: 1°C | HP Model 3456A | PC |
| DC Voltage Standard | Voltage: .3V to 350V<br>Short Term Stability:<br>better than .0002% | Systron Donner<br>Model M107 | PC |
| AC Calibrator | Frequency: 30Hz to 1kHz<br>Voltage: .3V to 30V<br>Voltage Accuracy: .04%<br>Voltage Stability: ±.02% | Fluke<br>Model 5200A | PC |
| Resistance Standard | Resistance: 100Ω<br>Accuracy: ±.0005% | Guideline Model:<br>9330/100 or<br>9330A/100 | PC |
| | Resistance: 1kΩ<br>Accuracy: ±.0005% | 9330/1k or 9330A/1k | PC |
| | Resistance: 10kΩ<br>Accuracy: ±.001% | 9330/10k or<br>9330A/10k | PC |
| | Resistance: 100kΩ<br>Accuracy: ±.001% | 9330/100k or<br>9330A/100k | PC |
| | Resistance: 1MΩ<br>Accuracy: ±.01% | 9330/1M | PC |
| | Resistance: 10MΩ<br>Accuracy: ±.01% | 9330/10M | PC |
| Computer | HP-IL or HP-IB Capability<br>With I/O ROM | HP Model HP-85A | PC |
| Function Generator | Frequency: 10Hz to 10kHz<br>Frequency Accuracy: .005% | HP Model 3325A | P |
| Temperature Calibrator Board | | HP P/N 03421-65505 | C |
| 3421A Calibration and Test Tape Cartridge | | HP P/N 03421-10001 | S |
| Diagnostic Terminal Block | | 03421-66504 | S |

*P = Performance; C = Calibration; S = Semiautomated Test & Calibration

## 1-4-6. MANUAL PERFORMANCE TESTS

1-4-7. The performance tests check the two functional areas of the instrument: voltmeter and counter. The voltmeter performance tests include dc volts, ac volts, and ohms. The counter performance test checks that the counter circuitry can operate at the specified frequency limits.

1-4-8. Each step in the performance test procedure will configure the instrument exactly as required for that step. None of the steps depend upon the configuration of a previous step. Thus, if you are interrupted while running a test, you can resume the test at any step in the procedure with confidence that the instrument is configured properly.

## 1-4-9. VOLTMETER PERFORMANCE TESTS (MANUAL)

1-4-10. The voltmeter performance tests verify the accuracy of the dc volts, ac volts, and ohms functions. Each function should be tested in the order given, starting with dc volts. Before running any of these tests, turn the HP 3421A power on and allow at least one hour for warm-up.

1-4-11. The HP 3421A is specified to operate within certain limits depending upon when it was last calibrated. If you are running the performance tests within 24 hours of the last calibration, use the 24 hour limits. Use the 90 day limits if the last calibration performed was longer than 24 hours, but less than 90 days. Likewise, use the 1 year limits if the last calibration performed was longer than 90 days but less than 1 year.

### 1-4-12. DC Volts Test (Manual)

1-4-13. The dc volts test limits and the instrument set-up information are listed in Table 1-4-2 and on the dc volts test card. Each step on the test card corresponds to a step in the test procedure. Because of this, each step number on the test card is shown in parenthesis (e.g, Step #1) in the procedure.

1-4-14. Unless otherwise specified, all test signals are applied to the HP 3421A Ω/V HI and Ω/V LO front panel terminals. As you go through the procedure, check and record the results on the test card, making sure that each test is within the limits specified. If any test is out of limits, refer to the calibration procedure (paragraph 1-4-34) before troubleshooting.

**NOTE**

*An instrument can be calibrated incorrectly on one or more ranges and still pass the calibration RAM portion of self test in certain situations. That is, if the instrument has been calibrated wrong on a particular range, the incorrect calibration constants are used to calculate the calibration RAM check sum.*

**4-15. Recommended Equipment.** The following test equipment is recommended for the dc volts test.

Digital Voltmeter (HP 3456A)
DC Volts Standard (Systron Donner Model M107)
HP-85 Computer

**Table 1-4-2. HP 3421A DC Volts Limits**

| HP 3421A Input | HP 3421A Range | HP 3421A Set Up | 24 Hour Limits High | 24 Hour Limits Low | 90 Day Limits High | 90 Day Limits Low | 1 Year Limits High | 1 Year Limits Low |
|---|---|---|---|---|---|---|---|---|
| Short | .3V | DCV, AZ ON, 5 ½ Digit | +.000005V | -.000005V | +.000006V | -.000006V | +.000006V | -.000006V |
| Short | 3V | | +0.00003V | -0.00003V | +0.00003V | -0.00003V | +0.00003V | -0.00003V |
| Short | 30V | | +0.0003V | -0.0003V | +0.0003V | -0.0003V | +0.0003V | -0.0003V |
| Short | 300V | | +0.003V | -0.003V | +0.003V | -0.003V | +0.003V | -0.003V |
| .3V | .3V | | +.300020V | +.299980V | +.300032V | +.299968V | +.300064V | +.299936V |
| .3V | 3V | | +0.30004V | +0.29996V | +0.30005V | +0.29995V | +0.30008V | +0.29992V |
| +1V | 3V | | +1.00007V | +0.99993V | +1.00010V | +0.99990V | +1.00021V | +0.99979V |
| -1V | 3V | | -1.00007V | -0.99993V | -1.00010V | -0.99990V | -1.00021V | -0.99979V |
| -3V | 3V | | -3.00014V | -2.99986V | -3.00025V | -2.99975V | -3.00057V | -2.99943V |
| +3V | 3V | | +3.00014V | +2.99986V | +3.00025V | +2.99975V | +3.00057V | +2.99943V |
| +3V | 3V | AZ OFF | +3.00017V | +2.99983V | +3.00028V | +2.99972V | +3.00060V | +2.99940V |
| | | AZ ON | | | | | | |
| +3V | 3V | 4 ½ Digit | +3.0002V | +2.9998V | +3.0003V | +2.9997V | +3.0007V | +2.9993V |
| +3V | 3V | 3 ½ Digit | +3.001V | +2.999V | +3.001V | +2.999V | +3.002V | +2.998V |
| +3V | 30V | 5 ½ Digit | +3.0005V | +2.9995V | +3.0006V | +2.9994V | +3.0009V | +2.9991V |
| +10V | 30V | | +10.0008V | +9.9992V | +10.0012V | +9.9988V | +10.0023V | +9.9977V |
| +30V | 30V | | +30.0018V | +29.9982V | +30.0029V | +29.9971V | +30.0062V | +29.9938V |
| +30V | 30V | AZ OFF | +30.0029V | +29.9971V | +30.0040V | +29.9960V | +30.0073V | +29.9927V |
| +300V | 300V | AZ ON | +300.018V | +299.982V | +300.030V | +299.970V | +300.062V | +299.938V |

**4-16. DC Volts Test Procedure.** Use the following procedure to test the dc volts function.

a. Make sure the motherboard is properly grounded to the chassis. This can be done by either making sure the slot 0 option is secured in place, or the four hex standoffs that support the slot 0 option are screwed into place. Some of the first instruments manufactured may have round standoffs riveted to the motherboard for slot 0, rather than the screw-in hex standoffs. If the instrument has round standoffs, secure the motherboard to the chassis by using the four additional loose standoffs and the four long screws that were supplied with the instrument.

b. With the HP 3421A and computer both off, connect the I/O cable (HP-IL or HP-IB).

c. Press the HP 3421A front panel switch to on and allow at least a one hour warm-up time. Apply power to the HP-85.

d. (Step #1) Disconnect all inputs to the HP 3421A and then send the RESET command by executing the following program line. This will cause the instrument to perform self test. Watch the HP 3421A display as self test is performed, making sure that no error numbers appear.

```
OUTPUT 901 ; "RS"
```

**NOTE**

*If the HP-IB Option is installed, the HP-IB address will not appear in the display when the RESET command is executed. The HP-IB address appears in the display only at power-on, or when the rear panel RESET switch is pressed in and released.*

e. (Step #2) Short the HP 3421A Ω/V HI and Ω/V LO front panel terminals together. Then take a reading on the .3V range by executing the following program:

```
10 OUTPUT 901 ; "T1F1R-1Z1N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

f. Check and record the reading on the test card.

g. (Step #3, 4, and 5) Leave the input terminals shorted and repeat steps e and f for the 3V, 30V, and 300V ranges. To do this, alter line 10 of the program in step e for the various ranges as follows:

<u>3V Range</u>

```
10 OUTPUT 901 ; "T1F1R0Z1N5OPN"
```

<u>30V Range</u>

```
10 OUTPUT 901 ; "T1F1R1Z1N5OPN"
```

<u>300V Range</u>

```
10 OUTPUT 901 ; "T1F1R2Z1N5OPN"
```

h. If any reading on the 3V, 30V, or 300V range is out of the specified limits, refer to the calibration procedure (paragraph 1-4-34).

i. Remove the short from the HP 3421A input terminals.

j. Set the dc standard for an output of 0.000000V.

k. Connect the HP 3421A to the digital voltmeter and the dc standard as shown in Figure 1-4-1.

**CAUTION**

*To prevent overloading the instrument or damage from switching transients, always uprange the HP 3421A before upranging the dc volts standard and always downrange the dc volts standard before downranging the Model 3421A.*

l. Set the dc volts standard for an output of .300000V, as displayed on the HP 3456A. Then take a reading by executing the following program:

```
10 OUTPUT 901 ; "T1F1R-1Z1N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

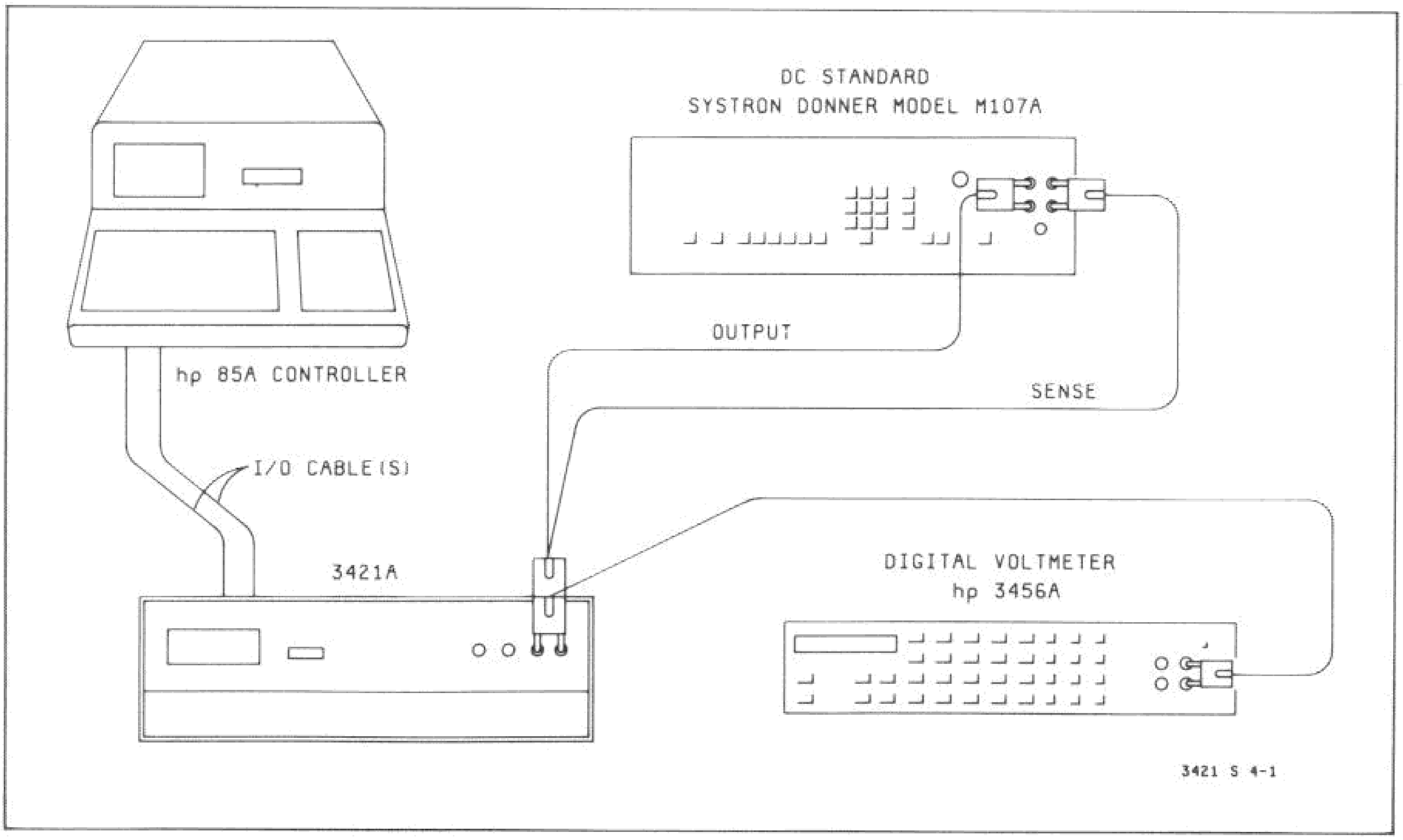



**Figure 1-4-1. DC Volts Accuracy Test**

m. (Step #6) Check and record the reading.

n. (Step #7) Leave the dc standard set to .300000V and take another reading on the 3V range by executing the following program. Check and record the reading.

```
10 OUTPUT 901 ; "T1F1R0Z1N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

o. (Step #8) Set the dc volts standard for an output of 1.00000V and then run the program from step n again. Check and record the reading.

p. (Step #9) Apply −1V to the HP 3421A by reversing the input leads, and then again run the program from step n. Check and record the reading.

q. (Step #10) Leave the input leads to the HP 3421A reversed and set the dc volts standard for a 3.00000V output (−3V input to the HP 3421A). Again run the program from step n. Check and record the reading.

r. (Step #11) Apply +3V to the HP 3421A by reversing the input leads. Run the program from step n once again. Check and record the reading.

s. (Step #12) With 3V applied to the HP 3421A, turn the autozero function off and take another reading by running the following program. Check and record the reading.

```
10 OUTPUT 901 ; "T1F1R0Z0N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

t. (Step #13) With 3V applied to the HP 3421A, select the 4 digit mode and take another reading by running the following program. Check and record the reading.

```
10 OUTPUT 901 ; "T1F1R0Z1N4OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

u. (Step #14) With 3V applied to the HP 3421A, take a reading in the 3 digit mode. To do this, run the program from step t but modify line 10 as follows. Check and record the reading.

```
10 OUTPUT 901 ; "T1F1R0Z1N3OPN"
```

v. (Step #15) This step checks the HP 3421A at 1/10 scale readings on the 30V range. To do this, make sure the dc volts standard is set to 3V and take a reading on the 30V range by running the following program. Check and record the reading.

```
10 OUTPUT 901 ; "T1F1R1Z1N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

w. (Step #16 and 17) This step checks the HP 3421A at ⅓ and full scale readings on the 30V range. To do this, first set the dc standard to 10.0000V and run the program from step v again. Check and record the reading. Then change the dc volts standard to 30.0000V and once again run the program from step v. Check and record the reading.

x. (Step #18) With 30V applied to the HP 3421A, take a reading with autozero off by running the program from step v with the following modification to line 10. Check and record the reading.

```
10 OUTPUT 901 ; "T1F1R1Z0N5OPN"
```

y. (Step #19) This step checks for full scale accuracy on the 300V range. Do the following:

1. Set the HP 3421A to the 300V range by executing the following program line:

```
OUTPUT 901 ; "T1F1R2Z1N5OPN"
```

2. Set the dc volts standard to a 300.000V output.

3. Take the full scale reading by executing the following program:

```
10 ENTER 901 ; A
20 DISP A
30 END
```

4. Check and record the reading.

z. (Step #20) Turn the output of the dc volts standard off. After the dc volts standard output is turned off, observe the following warning and then disconnect the dc volts standard and the digital voltmeter from the HP 3421A.

**WARNING**

*If you have a Systron Donner Model M107 as your dc volts standard, verify that the red "STANDBY" LED is lit. If you are using any other instrument as a dc volts standard, either ensure that the output is off according to the owner's manual or set the output to 0 volts before continuing.*

aa. (Step #21) This step checks the dc common mode rejection. To run this test, the HP 3421A must be powered from the ac line and the dc volts standard must have the low side of its output connected to earth ground. Do the following:

1. Set the HP 3421A to the .3V range by executing the following program line:

```
OUTPUT 901 ; "T1F1R-1Z1N5OPN"
```

2. Connect a 1 kΩ resistor (1/8W, 10%) between the HP 3421A Ω/V HI and Ω/V LO front panel terminals.

3. Take a reading by running the following program. Note the reading and write it down for future reference.

```
10 ENTER 901 ; A
20 DISP A
30 END
```

4. With the output of the dc volts standard turned off, connect the standard to the HP 3421A as shown in Figure 1-4-2.

5. Set the dc volts standard for an output of 350V and then turn its output on.

6. Take a reading by running the following program:

```
10 OUTPUT 901 ; "T1F1R-1Z1N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

7. Make sure the reading is within .00004V of the reading noted in step 3.

bb. Set the output of the dc volts standard to 0V and then disconnect it from the HP 3421A. This completes the dc volts test. If any test point was out of limits, refer to the calibration procedure (paragraph 1-4-34). If it still fails after being calibrated, refer to Section VIII of this chapter for troubleshooting.

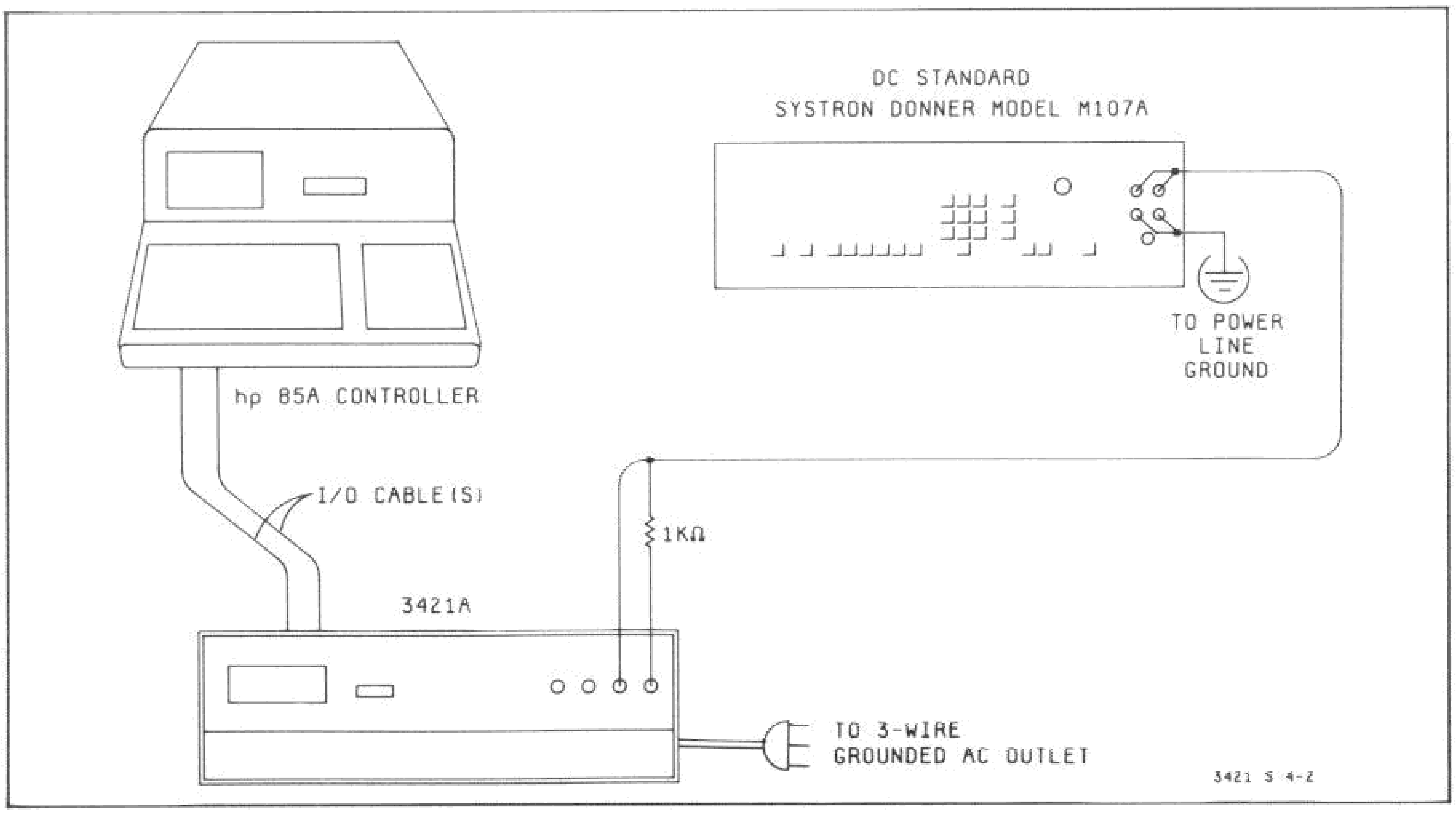



Figure 1-4-2. DC Common Mode Rejection Test

## 1-4-17. AC Volts Test (Manual)

1-4-18. The ac volts test limits are printed on the ac volts test card and in Table 1-4-3. Each step on the test card corresponds to a step in the procedure. The step number on the test card is shown in parenthesis in the procedure (e.g., Step #1).

Table 1-4-3. AC Volts Test Limits

| HP 3421A Range | HP 3421A Input | | 24 Hr Limits High | 24 Hr Limits Low | 90 Day Limits High | 90 Day Limits Low | 1 Yr Limits High | 1 Yr Limits Low |
|---|---|---|---|---|---|---|---|---|
| 3V | .3V, | 30Hz | .3062 | .2938 | .3080 | .2920 | .3230 | .2770 |
| | .3V, | 45Hz | .3047 | .2953 | .3065 | .2935 | .3215 | .2785 |
| | .3V, | 500Hz | .3047 | .2953 | .3065 | .2935 | .3215 | .2785 |
| | .3V, | 1kHz | .3062 | .2938 | .3080 | .2920 | .3230 | .2770 |
| | 2.9V, | 30Hz | 2.9296 | 2.8704 | 2.9340 | 2.8660 | 2.9490 | 2.8510 |
| | 2.9V, | 45Hz | 2.9151 | 2.8849 | 2.9195 | 2.8805 | 2.9345 | 2.8655 |
| | 2.9V, | 500Hz | 2.9151 | 2.8849 | 2.9195 | 2.8805 | 2.9345 | 2.8655 |
| | 2.9V, | 1kHz | 2.9256 | 2.8704 | 2.9340 | 2.8660 | 2.9490 | 2.8510 |
| 30V | 29V, | 30Hz | 29.301 | 28.699 | 29.350 | 28.650 | 29.490 | 28.510 |
| | 29V, | 45Hz | 29.156 | 28.844 | 29.205 | 28.795 | 29.345 | 28.655 |
| | 29V, | 500Hz | 29.156 | 28.844 | 29.205 | 28.795 | 29.345 | 28.655 |
| | 29V, | 1kHz | 29.301 | 28.699 | 29.350 | 28.650 | 29.490 | 28.510 |

**1-4-19. Recommended Equipment.** The following test equipment is recommended for the ac volts test.

HP-85 Computer
AC Calibrator (Fluke Model 5200A)

**1-4-20. AC Volts Test Procedure.** Before performing the ac volts performance test, make sure the dc volts test has been completed and the results are within the limits specified. Also make sure the HP 3421A has been warmed up for at least one hour. To perform the ac volts test, do the following:

a. Make sure the motherboard is properly grounded to the chassis. This can be done by either making sure the slot 0 option is secured in place, or the four hex standoffs that support the slot 0 option are screwed into place. Some of the first instruments manufactured may have round standoffs riveted to the motherboard for slot 0, rather than the screw-in hex standoffs. If the instrument has round standoffs, secure the motherboard to the chassis by using the four additional loose standoffs and the four long screws that were supplied with the instrument.

b. With the HP 3421A and computer both off, connect the I/O cable (HP-IL or HP-IB).

c. (Step #1) Disconnect all inputs to the HP 3421A and then send the RESET command by executing the following program line. This will cause the instrument to perform self test. Watch the HP 3421A display as self test is performed, making sure that no error numbers appear.

```
OUTPUT 901 ; "RS"
```

**NOTE**

*If the HP-IB Option is installed, the HP-IB address will not appear in the display when the RESET command is executed. The HP-IB address appears in the display only at power-on, or when the rear panel RESET switch is pressed in and released.*

d. (Step #2) Apply a .3000V RMS 30Hz signal to the HP 3421A Ω/V HI and Ω/V LO front panel terminals. Then take a reading on the 3V range by running the following program. Check and record the reading.

```
10 OUTPUT 901 ; "T1F2R0Z1N4OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

e. (Step #3) Change the input signal to .3000V RMS 45Hz and take a reading by running the program from step d. Check and record the reading.

f. (Step #4) Change the input signal to .3000V RMS 500Hz and take a reading by running the program from step d. Check and record the reading.

g. (Step #5) Change the input signal to .3000V RMS 1kHz and take a reading by running the program from step d. Check and record the reading.

h. (Step #6) Change the input signal to 2.9000V RMS 30Hz and take a reading on the 3V range by running the program from step d. Check and record the reading.

i. (Step #7) Change the input signal to 2.900V RMS 45Hz and take a reading by running the program from step d. Check and record the reading.

j. (Step #8) Change the input signal to 2.900V RMS 500Hz and take a reading by running the program from step d. Check and record the reading.

k. (Step #9) Change the input signal to 2.900V RMS 1kHz and take a reading by running the program from step d. Check and record the reading.

l. (Step #10) Change the input signal to 29.000V RMS 30Hz and take a reading on the 30V range by running the following program. Check and record the reading.

```
10 OUTPUT 901 "T1F2R1Z1N4OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

m. (Step #11) Change the input signal to 29.000V RMS 45Hz and take a reading by running the program from step l. Check and record the reading.

n. (Step #12) Change the input signal to 29.000V RMS 500Hz and take a reading by running the program from step l. Check and record the reading.

o. (Step #13) Change the input signal to 29.000V RMS 1kHz and take a reading by running the program from step l. Check and record the reading.

p. This completes the ac volts test. If any test was out of the specified limits, try calibrating the instrument for ac volts before troubleshooting (see paragraph 1-4-34).

## 1-4-21. Ohms Test (Manual)

1-4-22. The HP 3421A has two ohms functions (2-wire and 4-wire), but only one set of ohms limits. The instrument is calibrated at the factory for 4-wire ohms. If your application involves 2-wire ohms measurements, calibrate for 2-wire ohms before running the ohms test. Use the same leads to calibrate that will be used for the 2-wire ohms test. This is necessary because of the different impedances that exist between leads. When the instrument is calibrated for 4-wire ohms, lead impedance is compensated for, resulting in different ohms calibration constants than those used for the 2-wire ohms function. Thus, if the instrument is calibrated for 4-wire ohms and you perform the 2-wire ohms procedure, or vice versa, the results may be out of the specified limits.

1-4-23. The ohms function can be tested using either full scale or ⅓ scale inputs (e.g., 3kΩ or 1kΩ resistors to check the 3kΩ range). Both of these test limits are given in Table 1-4-4 and on the ohms performance test card. The test step numbers shown in parentheses on the test card are for the 1/3 scale tests.

1-4-24. It is preferable to make full scale measurements when running the ohms test. However, if you do not have enough precision resistors to do this, it is permissible to make 1/3 scale readings. For example, on the 300 ohm range you can use a single 100Ω precision resistor and make a ⅓ scale reading instead of connecting three 100Ω resistors in series for a full scale reading.

Table 1-4-4. Ohms Test Limits

| HP 3421A Input | HP 3421A Range | 24 Hr Limits High | 24 Hr Limits Low | 90 Day Limits High | 90 Day Limits Low | 1 Year Limits High | 1 Year Limits Low |
|---|---|---|---|---|---|---|---|
| Short | 300 | +.005 | −.005 | +.006 | −.006 | +.006 | −.006 |
| Short | 3k | +.03 | −.03 | +.03 | −.03 | +.03 | −.03 |
| Short | 30k | +.3 | −.3 | +.3 | −.3 | +.3 | −.3 |
| Short | 300k | +3 | −3 | +3 | −3 | +3 | −3 |
| Short | 3M | +30 | −30 | +30 | −30 | +30 | −30 |
| Short | 30M | +300 | −300 | +300 | −300 | +300 | −300 |
| 300 | 300 | 300.019 | 299.981 | 300.042 | 299.958 | 300.057 | 299.943 |
| (100) | | 100.01 | 99.99 | 100.018 | 99.982 | 100.023 | 99.977 |
| 3k | 3k | 3000.14 | 2999.86 | 3000.36 | 2999.64 | 3000.51 | 2999.49 |
| (1k) | | 1000.07 | 999.93 | 1000.14 | 999.86 | 1000.19 | 999.81 |
| 30k | 30k | 30001.4 | 29998.6 | 30003.6 | 29996.4 | 30005.1 | 29994.9 |
| (10k) | | 10000.7 | 9999.3 | 10001.4 | 9998.6 | 10001.9 | 9998.1 |
| 300k | 300k | 300014 | 299986 | 300036 | 299964 | 300051 | 299949 |
| (100k) | | 100007 | 99993 | 100014 | 99986 | 100019 | 99981 |
| 3M | 3M | 3000330 | 2999670 | 3000450 | 2999550 | 3000570 | 2999430 |
| (1M) | | 1000130 | 999870 | 1000170 | 999830 | 1000210 | 999790 |
| 30M | 30M | 30027900 | 29972100 | 30032300 | 29967700 | 30034800 | 29965200 |
| (10M) | | 10009500 | 9990500 | 10011000 | 9989000 | 10011800 | 9988200 |

**1-4-25. Recommended Equipment.** The following equipment is recommended to run the ohms test.

HP-85 Computer
100Ω ±.0005% (Guildline Model 9330/100 or 9330A/100)
1kΩ ±.0005% (Guildline Model 9330/1k or 9330A/1k)
10kΩ ±.001% (Guildline Model 9330/10k or 9330A/10k)
100kΩ ±.001% (Guildline Model 9330/100k or 9330A/100k)
1MΩ ±.002% (Guildline Model 9330/1M)
10MΩ ±.01% (Guildline Model 9330/10M)

**1-4-26. Ohms Test Procedure.** Make sure the HP 3421A dc volts test has been performed and has passed before doing the ohms test. Also make sure the HP 3421A has been warmed up for at least one hour before running the ohms test.

1-4-27. When performing the ohms test, the test leads that connect to the standard resistance should be as short as possible. Long leads can pick up noise, which could give an invalid reading.

1-4-28. If the HP 3421A is to be tested for 2-wire ohms, make sure the instrument has been calibrated for 2-wire ohms. If it is to be tested for 4-wire ohms, make sure it is calibrated for 4-wire ohms. The instrument is calibrated at the factory for 4-wire ohms. For the 2-wire ohms test, all test resistors are applied across the HP 3421A Ω/V HI and Ω/V LO front panel terminals using the same test leads that were used for calibration. For the 4-wire ohms test, the HP 3421A input terminals should be configured as shown in Figure 1-4-3 for shorted inputs, and as shown in Figure 1-4-4 for resistance measurements.

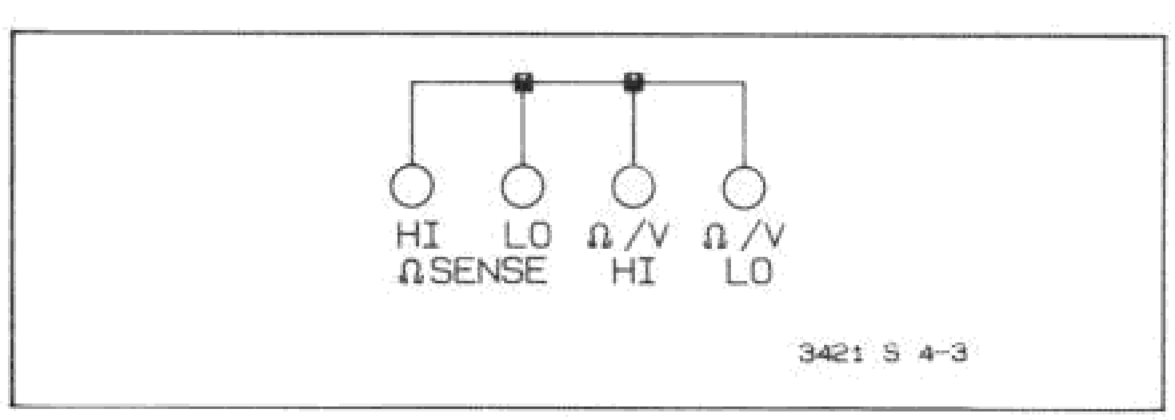



Figure 1-4-3. 4-wire Ohms Test Connection (Shorted Inputs)

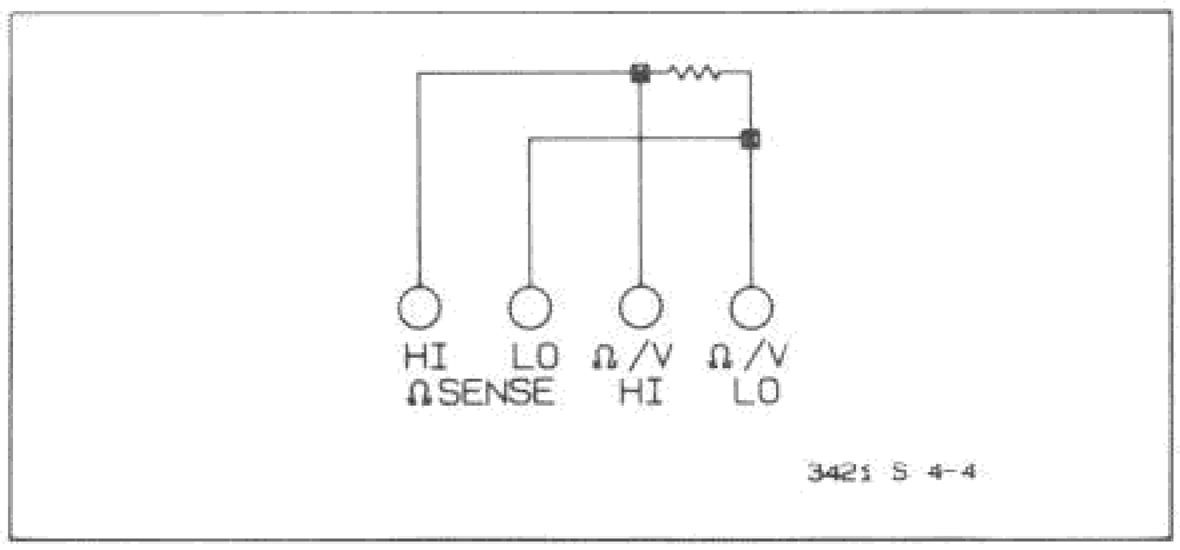



**Figure 1-4-4. 4-wire Ohms Test Connection (Resistance Measurements)**

1-4-29. To run the ohms test, do the following:

a. Make sure the motherboard is properly grounded to the chassis. This can be done by either making sure the slot 0 option is secured in place, or the four hex standoffs that support the slot 0 option are screwed into place. Some of the first instruments manufactured may have round standoffs riveted to the motherboard for slot 0, rather than the screw-in hex standoffs. If the instrument has round standoffs, secure the motherboard to the chassis by using the four additional loose standoffs and the four long screws that were supplied with the instrument.

b. With the power off on both the HP-85 and HP 3421A, connect the I/O cable (HP-IL or HP-IB) from the HP-85 to the HP 3421A.

c. Press the HP 3421A front panel switch to on and allow at least a one hour warm-up time.

d. (Step #1) Disconnect all inputs to the HP 3421A and then send the RESET command to the HP 3421A by executing the following program line. This will cause the instrument to perform self test. Watch the HP 3421A display as self test is performed, making sure that no error numbers appear.

```
OUTPUT 901 ; "RS"
```

**NOTE**

*If the HP-IB Option is installed, the HP-IB address will not appear in the display when the RESET command is executed. The HP-IB address appears in the display only at power-on, or when the rear panel RESET switch is pressed in and released.*

e. (Step #2) If you are testing the 2-wire ohms function, short the Ω/V HI and Ω/V LO input terminals at the end of the test leads that were used for calibration. If you are testing the 4-wire ohms function, short the SENSE and INPUT terminals as shown in Figure 1-4-3. Then, configure the 300Ω range for the appropriate 2-wire ohms or 4-wire ohms function and take a reading by running one of the following programs. Check and record the reading on the performance test card.

<u>2-wire ohms</u>

```
10 OUTPUT 901 ; "T1F3R2Z1N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

4-wire ohms

```
10 OUTPUT 901 ; "T1F4R2Z1N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

f. (Step #3, 4, 5, 6, and 7) Leave the HP 3421A input terminals shorted and then take a reading on the 3kΩ, 30kΩ, 300kΩ, 3MΩ, and 30MΩ ranges by modifying line 10 of one of the preceding programs from step e as follows:

2-wire ohms

```
3kΩ     OUTPUT 901 ; "T1F3R3Z1N5OPN"
30kΩ    OUTPUT 901 ; "T1F3R4Z1N5OPN"
300kΩ   OUTPUT 901 ; "T1F3R5Z1N5OPN"
3MΩ     OUTPUT 901 ; "T1F3R6Z1N5OPN"
30MΩ    OUTPUT 901 ; "T1F3R7Z1N5OPN"
```

4-wire ohms

```
3kΩ     OUTPUT 901 ; "T1F4R3Z1N5OPN"
30kΩ    OUTPUT 901 ; "T1F4R4Z1N5OPN"
300kΩ   OUTPUT 901 ; "T1F4R5Z1N5OPN"
3MΩ     OUTPUT 901 ; "T1F4R6Z1N5OPN"
30MΩ    OUTPUT 901 ; "T1F4R7Z1N5OPN"
```

g. Check and record the readings from step f. If any reading is out of the specified limits, perform the ohms calibration procedure (see paragraph 1-4-34).

h. (Step 8) Remove the short from the HP 3421A input terminals and then connect either three 100Ω standard resistors in series, or a single 100Ω resistor across the input terminals (see paragraphs 1-4-23 and 1-4-24). If the 2-wire ohms function is to be checked, connect the resistor(s) across the Ω/V HI and Ω/V LO input terminals at the end of the leads to be used. If the 4-wire ohms function is to be checked, connect the resistor(s) as shown in Figure 1-4-4. Then do the following:

1. Take a reading on the 300Ω range by running one of the following programs:

2-wire ohms

```
10 OUTPUT 901 ; "T1F3R2Z1N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

4-wire ohms

```
10 OUTPUT 901 ; "T1F4R2Z1N5OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

2. Check and record the reading.

i. (Step #9 through 13) Check the 3kΩ, 30kΩ, 300kΩ, 3MΩ, and 30MΩ ranges by connecting the appropriate standard resistances to the input terminals for either the 2-wire ohms or 4-wire ohms functions. Then modify one of the programs in the preceding step to reflect the appropriate range. The various ranges are selected by the following commands: R3 = 3kΩ; R4 = 30kΩ; R5 = 300kΩ; R6 = 3MΩ; R7 = 30MΩ. Check and record the readings.

j. This completes the ohms test. If any range fails, try calibrating the instrument (see paragraph 1-4-34). If a range fails after it is calibrated, refer to Section VIII for troubleshooting.

**NOTE**

*If the exact value of the standard resistance is known to be slightly different than the ⅓ or full scale inputs listed on the test card, alter the high and low limits accordingly. Example: if the standard resistance is known to be exactly 300.025Ω when testing the 300 ohm range, the high limit becomes 300.044Ω (300.025 + .019) and the low limit becomes 299.990Ω (299.971 + .019).*

## 1-4-30. Counter Test (Manual)

1-4-31. This test verifies that the counter circuitry will respond to frequencies as low as 10 Hz, and as high as 10 kHz. The counter circuitry cannot be calibrated.

**1-4-32. Recommended Equipment.** The following equipment is recommended to run the counter test.

HP-85 Computer
HP Model 3325A Function Generator

**1-4-33. Counter Test Procedure.** To perform the counter test, do the following.

a. Make sure the motherboard is properly grounded to the chassis. This can be done by either making sure the slot 0 option is secured in place, or the four hex standoffs that support the slot 0 option are screwed into place. Some of the first instruments manufactured may have round standoffs riveted to the motherboard for slot 0, rather than the screw-in hex standoffs. If the instrument has round standoffs, secure the motherboard to the chassis by using the four additional loose standoffs and the four long screws that were supplied with the instrument.

b. With the power off on both the HP-85 and HP 3421A, connect the I/O cable (HP-IL or HP-IB) from the HP-85 to the HP 3421A.

c. Press the HP 3421A front panel switch to on and allow at least a one hour warm-up time.

d. (Step #1) Disconnect all inputs to the HP 3421A and then send the RESET command to the HP 3421A by executing the following program line. This will cause the instrument to perform self test. Watch the HP 3421A display as self test is performed, making sure that no error numbers appear.

```
OUTPUT 901 ; "RS"
```

**NOTE**

*If the HP-IB Option is installed, the HP-IB address will not appear in the display when the RESET command is executed. The HP-IB address appears in the display only at power-on, or when the rear panel RESET switch is pressed in and released.*

e. Connect the output of the HP 3325A to the HP 3421A Ω/V HI and Ω/V LO front panel terminals. Set the HP 3325A output to approximately 5V RMS and a frequency of exactly 10 Hz.

f. (Step #2) Take a reading by running the following program. Check and record the reading. It should be 10 ±.1Hz.

```
10 OUTPUT 901 ; "T1F7G1N5RA1OPN"
20 ENTER 901 ; A
30 DISP A
40 END
```

g. Change the output of the HP 3325A to exactly 10 kHz at approximately 5V RMS.

h. (Step #3) Take a reading by running the program from step f with line 10 modified as shown. Check and record the reading. It should be 1000 ±6Hz.

```
10 OUTPUT 901 ; "T1F7G0N5RA1OPN"
```

i. This completes the counter test. Since the counter circuitry cannot be calibrated, it will be necessary to troubleshoot this circuitry if it was out of the specified limits. See Section VIII for troubleshooting information.

# PERFORMANCE TEST CARD

## 24 HOUR LIMITS

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit

Serial Number__________

Test Performed By__________

Date__________

Reference Temperature__________

Date of Last Calibration__________

**DC Volts Test**

| Step # | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | Short | .3V Range | +.000005V | ____ | −.000005V | ____ | ____ |
| 3 | Short | 3V Range | +.00003V | ____ | −.00003V | ____ | ____ |
| 4 | Short | 30V Range | +.0003V | ____ | −.0003V | ____ | ____ |
| 5 | Short | 300V Range | +.003V | ____ | −.003V | ____ | ____ |
| 6 | +.3V | .3V Range | +.300020V | ____ | +.299980V | ____ | ____ |
| 7 | +.3V | 3V Range | +.30004V | ____ | +.29996V | ____ | ____ |
| 8 | +1V | 3V Range | +1.00007V | ____ | +.99993V | ____ | ____ |
| 9 | −1V | 3V Range | −1.00007V | ____ | −.99993V | ____ | ____ |
| 10 | −3V | 3V Range | −3.00014V | ____ | −2.99986V | ____ | ____ |
| 11 | +3V | 3V Range | +3.00014V | ____ | +2.99986V | ____ | ____ |
| 12 | +3V | Autozero Off | +3.00017V | ____ | +2.99983V | ____ | ____ |
| 13 | +3V | 4 ½ Digit | +3.0002V | ____ | +2.9998V | ____ | ____ |
| 14 | +3V | 3 ½ Digit | +3.001V | ____ | +2.999V | ____ | ____ |
| 15 | +3V | 30V Range | +3.0005V | ____ | +2.9995V | ____ | ____ |
| 16 | +10V | 30V Range | +10.0008V | ____ | +9.9992V | ____ | ____ |
| 17 | +30V | 30V Range | +30.0018V | ____ | +29.9982V | ____ | ____ |
| 18 | +30V | Autozero Off | +30.0029V | ____ | +29.9971V | ____ | ____ |
| 19 | +300V | 300V Range | +300.018V | ____ | +299.982V | ____ | ____ |
| 20 | Open | | | | | | |
| 21 | See Below | CMR Test | (1) ____ | | | | |
| | | | (2) ____ | | | ____ | ____ |

CMR Test

1. Connect a 1 kΩ resistor between the HP 3421A Ω/V HI and Ω/V LO front panel terminals.
2. Take a reading.
3. Apply 350V DC between earth ground and the Ω/V HI terminal.
4. The HP 3421A reading should now be within .00004V of the reading in step 2.

# PERFORMANCE TEST CARD

## 90 DAY LIMITS

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit

Serial Number______________

Test Performed By______________
Date______________
Reference Temperature______________
Date of Last Calibration______________

**DC Volts Test**

| Step # | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | Short | .3V Range | +.000006V | ______ | −.000006V | ______ | ______ |
| 3 | Short | 3V Range | +.00003V | ______ | −.00003V | ______ | ______ |
| 4 | Short | 30V Range | +.0003V | ______ | −.0003V | ______ | ______ |
| 5 | Short | 300V Range | +.003V | ______ | −.003V | ______ | ______ |
| 6 | +.3V | .3V Range | +.300032V | ______ | +.299968V | ______ | ______ |
| 7 | +.3V | 3V Range | +.30005V | ______ | +.29995V | ______ | ______ |
| 8 | +1V | 3V Range | +1.00010V | ______ | +.99990V | ______ | ______ |
| 9 | −1V | 3V Range | −1.00010V | ______ | −.99990V | ______ | ______ |
| 10 | −3V | 3V Range | −3.00025V | ______ | −2.99975V | ______ | ______ |
| 11 | +3V | 3V Range | +3.00025V | ______ | +2.99975V | ______ | ______ |
| 12 | +3V | Autozero Off | +3.00028V | ______ | +2.99972V | ______ | ______ |
| 13 | +3V | 4 ½ Digit | +3.0003V | ______ | +2.9997V | ______ | ______ |
| 14 | +3V | 3 ½ Digit | +3.001V | ______ | +2.999V | ______ | ______ |
| 15 | +3V | 30V Range | +3.0006V | ______ | +2.9994V | ______ | ______ |
| 16 | +10V | 30V Range | +10.0012V | ______ | +9.9988V | ______ | ______ |
| 17 | +30V | 30V Range | +30.0029V | ______ | +29.9971V | ______ | ______ |
| 18 | +30V | Autozero Off | +30.0040V | ______ | +29.9960V | ______ | ______ |
| 19 | +300V | 300V Range | +300.030V | ______ | +299.970V | ______ | ______ |
| 20 | Open | | | | | | |
| 21 | See Below | CMR Test | (1) ______ | | | | |
| | | | (2) ______ | | | ______ | ______ |

CMR Test

1. Connect a 1 kΩ resistor between the HP 3421A Ω/V HI and Ω/V LO front panel terminals.
2. Take a reading.
3. Apply 350V DC between earth ground and the Ω/V HI terminal.
4. The HP 3421A reading should now be within .00004V of the reading in step 2.

# PERFORMANCE TEST CARD

## 1 YEAR LIMITS

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit

Serial Number________

Test Performed By________
Date ________
Reference Temperature________
Date of Last Calibration________

**DC Volts Test**

| Step # | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | Short | .3V Range | +.000006V | ______ | -.000006V | ______ | ______ |
| 3 | Short | 3V Range | +.00003V | ______ | -.00003V | ______ | ______ |
| 4 | Short | 30V Range | +.0003V | ______ | -.0003V | ______ | ______ |
| 5 | Short | 300V Range | +.003V | ______ | -.003V | ______ | ______ |
| 6 | +.3V | .3V Range | +.300064V | ______ | +.299936V | ______ | ______ |
| 7 | +.3V | 3V Range | +.30008V | ______ | +.29992V | ______ | ______ |
| 8 | +1V | 3V Range | +1.00021V | ______ | +.99979V | ______ | ______ |
| 9 | -1V | 3V Range | -1.00021V | ______ | -.99979V | ______ | ______ |
| 10 | -3V | 3V Range | -3.00057V | ______ | -2.99943V | ______ | ______ |
| 11 | +3V | 3V Range | +3.00057V | ______ | +2.99943V | ______ | ______ |
| 12 | +3V | Autozero Off | +3.00060V | ______ | +2.99940V | ______ | ______ |
| 13 | +3V | 4 ½ Digit | +3.0007V | ______ | +2.9993V | ______ | ______ |
| 14 | +3V | 3 ½ Digit | +3.002V | ______ | +2.998V | ______ | ______ |
| 15 | +3V | 30V Range | +3.0009V | ______ | +2.9991V | ______ | ______ |
| 16 | +10V | 30V Range | +10.0023V | ______ | +9.9977V | ______ | ______ |
| 17 | +30V | 30V Range | +30.0062V | ______ | +29.9938V | ______ | ______ |
| 18 | +30V | Autozero Off | +30.0073V | ______ | +29.9927V | ______ | ______ |
| 19 | +300V | 300V Range | +300.062V | ______ | +299.938V | ______ | ______ |
| 20 | Open | | | | | | |
| 21 | See Below | CMR Test | (1) ______ | | | | |
| | | | (2) ______ | | | ______ | ______ |

CMR Test

1. Connect a 1 kΩ resistor between the HP 3421A Ω/V HI and Ω/V LO front panel terminals.
2. Take a reading.
3. Apply 350V DC between earth ground and the Ω/V HI terminal.
4. The HP 3421A reading should now be within .00004V of the reading in step 2.

## PERFORMANCE TEST CARD

## 24 HOUR LIMITS

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit
Serial Number__________

Test Performed By__________
Date________
Reference Temperature__________
Date of Last Calibration__________

**AC Volts Test**

| Step# | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | .3V 30Hz | ACV 3V Range | .3062V | ____ | .2938V | ____ | ____ |
| 3 | .3V 45Hz | | .3047V | ____ | .2953V | ____ | ____ |
| 4 | .3V 500Hz | | .3047V | ____ | .2953V | ____ | ____ |
| 5 | .3V 1kHz | | .3062V | ____ | .2938V | ____ | ____ |
| 6 | 2.9V 30Hz | | 2.9296V | ____ | 2.8704V | ____ | ____ |
| 7 | 2.9V 45Hz | | 2.9151V | ____ | 2.8849V | ____ | ____ |
| 8 | 2.9V 500 Hz | | 2.9151V | ____ | 2.8849V | ____ | ____ |
| 9 | 2.9V 1kHz | | 2.9256V | ____ | 2.8704V | ____ | ____ |
| 10 | 29V 30Hz | ACV 30V Range | 29.301V | ____ | 28.699V | ____ | ____ |
| 11 | 29V 45Hz | | 29.156V | ____ | 28.844V | ____ | ____ |
| 12 | 29V 500Hz | | 29.156V | ____ | 28.844V | ____ | ____ |
| 13 | 29V 1kHz | | 29.301V | ____ | 28.699V | ____ | ____ |

# PERFORMANCE TEST CARD

## 90 DAY LIMITS

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit

Serial Number_______________

Test Performed By_______________
Date__________
Reference Temperature_______________
Date of Last Calibration_______________

**AC Volts Test**

| Step# | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | .3V 30Hz | ACV 3V Range | .3080V | ________ | .2920V | ________ | ________ |
| 3 | .3V 45Hz | | .3065V | ________ | .2935V | ________ | ________ |
| 4 | .3V 500Hz | | .3065V | ________ | .2935V | ________ | ________ |
| 5 | .3V 1kHz | | .3080V | ________ | .2920V | ________ | ________ |
| 6 | 2.9V 30Hz | | 2.9340V | ________ | 2.8660V | ________ | ________ |
| 7 | 2.9V 45Hz | | 2.9195V | ________ | 2.8805V | ________ | ________ |
| 8 | 2.9V 500Hz | | 2.9195V | ________ | 2.8805V | ________ | ________ |
| 9 | 2.9V 1kHz | | 2.9340V | ________ | 2.8660V | ________ | ________ |
| 10 | 29V 30Hz | ACV 30V Range | 29.350V | ________ | 28.650V | ________ | ________ |
| 11 | 29V 45Hz | | 29.205V | ________ | 28.795V | ________ | ________ |
| 12 | 29V 500Hz | | 29.205V | ________ | 28.795V | ________ | ________ |
| 13 | 29V 1kHz | | 29.350V | ________ | 28.650V | ________ | ________ |

## PERFORMANCE TEST CARD

## 1 YEAR LIMITS

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit

Serial Number________________

Test Performed By________________

Date________________

Reference Temperature________________

Date of Last Calibration________________

**AC Volts Test**

| Step# | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | .3V 30Hz | ACV 3V Range | .3230V | ______ | .2770V | ______ | ______ |
| 3 | .3V 45Hz | | .3215V | ______ | .2785V | ______ | ______ |
| 4 | .3V 500Hz | | .3215V | ______ | .2785V | ______ | ______ |
| 5 | .3V 1kHz | | .3230V | ______ | .2770V | ______ | ______ |
| 6 | 2.9V 30Hz | | 2.9490V | ______ | 2.8510V | ______ | ______ |
| 7 | 2.9V 45Hz | | 2.9345V | ______ | 2.8655V | ______ | ______ |
| 8 | 2.9V 500Hz | | 2.9345V | ______ | 2.8655V | ______ | ______ |
| 9 | 2.9V 1kHz | | 2.9490V | ______ | 2.8510V | ______ | ______ |
| 10 | 29V 30Hz | ACV 30V Range | 29.490V | ______ | 28.510V | ______ | ______ |
| 11 | 29V 45Hz | | 29.345V | ______ | 28.655V | ______ | ______ |
| 12 | 29V 500Hz | | 29.345V | ______ | 28.655V | ______ | ______ |
| 13 | 29V 1kHz | | 29.490V | ______ | 28.510V | ______ | ______ |

# PERFORMANCE TEST CARD

## 24 HOUR LIMITS

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit

Serial Number________________

Test Performed By________________
Date ____________
Reference Temperature________________
Date of Last Calibration________________

**OHMS Test**

| Step# | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | Short | 300 Range (R2) | +.005 | ________ | −.005 | ________ | ________ |
| 3 | Short | 3k Range (R3) | +.03 | ________ | −.03 | ________ | ________ |
| 4 | Short | 30k Range (R4) | +.3 | ________ | −.3 | ________ | ________ |
| 5 | Short | 300k Range (R5) | +3 | ________ | −3 | ________ | ________ |
| 6 | Short | 3M Range (R6) | +30 | ________ | −30 | ________ | ________ |
| 7 | Short | 30M Range (R7) | +300 | ________ | −300 | ________ | ________ |
| 8 | 300 | 300 Range (R2) | +300.019 | ________ | +299.971 | ________ | ________ |
| (8) | 100 | | +100.01 | ________ | +99.99 | ________ | ________ |
| 9 | 3k | 3k Range (R3) | +3000.14 | ________ | +2999.86 | ________ | ________ |
| (9) | 1k | | +1000.07 | ________ | +999.93 | ________ | ________ |
| 10 | 30k | 30k Range (R4) | +30001.4 | ________ | +29998.6 | ________ | ________ |
| (10) | 10k | | +10000.7 | ________ | +9999.3 | ________ | ________ |
| 11 | 300k | 300k Range (R5) | +300014 | ________ | +299986 | ________ | ________ |
| (11) | 100k | | +100007 | ________ | +99993 | ________ | ________ |
| 12 | 3M | 3M Range (R6) | +3000330 | ________ | +2999670 | ________ | ________ |
| (12) | 1M | | +1000130 | ________ | +999870 | ________ | ________ |
| 13 | 30M | 30M Range (R7) | +30027900 | ________ | +29972100 | ________ | ________ |
| (13) | 10M | | +10009500 | ________ | +9990500 | ________ | ________ |

# PERFORMANCE TEST CARD

## 90 DAY LIMITS

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit

Serial Number__________

Test Performed By__________

Date__________

Reference Temperature__________

Date of Last Calibration__________

**OHMS Test**

| Step# | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | Short | 300 Range (R2) | +.006 | ____ | −.006 | ____ | ____ |
| 3 | Short | 3k Range (R3) | +.03 | ____ | −.03 | ____ | ____ |
| 4 | Short | 30k Range (R4) | +.3 | ____ | −.3 | ____ | ____ |
| 5 | Short | 300k Range (R5) | +3 | ____ | −3 | ____ | ____ |
| 6 | Short | 3M Range (R6) | +30 | ____ | −30 | ____ | ____ |
| 7 | Short | 30M Range (R7) | +300 | ____ | −300 | ____ | ____ |
| 8 | 300 | 300 Range (R2) | +300.042 | ____ | +299.958 | ____ | ____ |
| (8) | 100 | | +100.018 | ____ | +99.982 | ____ | ____ |
| 9 | 3k | 3k Range (R3) | +3000.36 | ____ | +2999.64 | ____ | ____ |
| (9) | 1k | | +1000.14 | ____ | +999.86 | ____ | ____ |
| 10 | 30k | 30k Range (R4) | +30003.6 | ____ | +29996.4 | ____ | ____ |
| (10) | 10k | | +10001.4 | ____ | +9998.6 | ____ | ____ |
| 11 | 300k | 300k Range (R5) | +300036 | ____ | +299964 | ____ | ____ |
| (11) | 100k | | +100014 | ____ | +99986 | ____ | ____ |
| 12 | 3M | 3M Range (R6) | +3000450 | ____ | +2999550 | ____ | ____ |
| (12) | 1M | | +1000170 | ____ | +999830 | ____ | ____ |
| 13 | 30M | 30M Range (R7) | +30032300 | ____ | +29967700 | ____ | ____ |
| (13) | 10M | | +10011000 | ____ | +9989000 | ____ | ____ |

## PERFORMANCE TEST CARD

## 1 YEAR LIMITS

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit

Serial Number______________

Test Performed By______________
Date__________
Reference Temperature______________
Date of Last Calibration______________

**OHMS Test**

| Step# | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | Short | 300 Range (R2) | +.006 | ______ | −.006 | ______ | ______ |
| 3 | Short | 3k Range (R3) | +.03 | ______ | −.03 | ______ | ______ |
| 4 | Short | 30k Range (R4) | +.3 | ______ | −.3 | ______ | ______ |
| 5 | Short | 300k Range (R5) | +3 | ______ | −3 | ______ | ______ |
| 6 | Short | 3M Range (R6) | +30 | ______ | −30 | ______ | ______ |
| 7 | Short | 30M Range (R7) | +300 | ______ | −300 | ______ | ______ |
| 8 | 300 | 300 Range (R2) | +300.057 | ______ | +299.943 | ______ | ______ |
| (8) | 100 | | +100.023 | ______ | +99.977 | ______ | ______ |
| 9 | 3k | 3k Range (R3) | +3000.51 | ______ | +2999.49 | ______ | ______ |
| (9) | 1k | | +1000.19 | ______ | +999.81 | ______ | ______ |
| 10 | 30k | 30k Range (R4) | +30005.1 | ______ | +29994.9 | ______ | ______ |
| (10) | 10k | | +10001.9 | ______ | +9998.1 | ______ | ______ |
| 11 | 300k | 300k Range (R5) | +300051 | ______ | +299949 | ______ | ______ |
| (11) | 100k | | +100019 | ______ | +99981 | ______ | ______ |
| 12 | 3M | 3M Range (R6) | +3000570 | ______ | +2999430 | ______ | ______ |
| (12) | 1M | | +1000210 | ______ | +999790 | ______ | ______ |
| 13 | 30M | 30M Range (R7) | +30034800 | ______ | +29965200 | ______ | ______ |
| (13) | 10M | | +10011800 | ______ | +9988200 | ______ | ______ |

## PERFORMANCE TEST CARD

Hewlett-Packard Model 3421A
Data Acquisition and Control Unit
Serial Number__________

Test Performed By__________
Date__________
Reference Temperature__________

**Counter Test**

| Step# | HP 3421A Input | Set-Up | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|---|---|
| 1 | Open | RESET | | | | | |
| 2 | 10 Hz, 5V RMS | Frequency, 10 Second Gate Time | 10.1 Hz | ______ | 9.9 Hz | ______ | ______ |
| 3 | 10 kHz, 5V RMS | Frequency, 1 Second Gate Time | 10006 Hz | ______ | 9994 Hz | ______ | ______ |

## 1-4-34. MANUAL CALIBRATION

1-4-35. Instrument calibration is electronic, which means there are no manual adjustments to be made to the HP 3421A. Calibration is performed by applying a known good source to the HP 3421A front panel terminals. The value of the source is then compared to the average value of ten readings. From this, the instrument calculates a calibration constant and stores it in the calibration RAM. These constants are used to calculate future readings. Calibration procedures are given for dc volts, ac volts, ohms, and temperature functions.

1-4-36. Calibration RAM power is backed up by a long life 3V battery. This allows constants stored in RAM to be maintained, even if power has been removed or the main battery is depleted.

1-4-37. If the HP 3421A display error indicator turns on during any portion of the calibration procedure, it most likely indicates that a procedural error has taken place. If a procedural error causes the error indicator to turn on, the step that caused the error is not performed and must be repeated. Repeating the step will not clear the error indicator. However, the repeated step will be performed if it is done correctly. Because of this, it is recommended that you not start calibration with the error indicator turned on. Also, if it turns on during calibration, clear it by inputting the first four status registers, as explained under calibration error codes. Calibrating with the error indicator on could result in an incorrect calibration.

1-4-38. The ac volts function uses both the ac volts and dc volts calibration constants. Therefore, make sure the dc volts function is properly calibrated before calibrating the ac volts function. To do this, you can either calibrate the dc volts function first, or perform the dc volts performance test before doing an ac volts calibration. The ohms and temperature functions can be calibrated independent of the dc volts or ac volts functions.

1-4-39. Each step in the procedures for dc volts and ac volts will configure the instrument exactly as required for that step. That is, none of the steps for dc volts and ac volts depend upon the configuration of a previous step. However, this is not true for the calibration of the ohms and temperature functions. Several steps for the ohms and temperature functions are dependent upon the configuration of a previous step.

### 1-4-40. Calibration Error Codes

1-4-41. When performing the calibration procedure, there are several procedural errors that cause the HP 3421A display error indicator to turn on. The following lists items to check if the display error indicator is encountered. Any one of these items will cause the error indicator to turn on during calibration.

a. Make sure the rear panel calibration enable switch (S501 segment #8) is in the enable position (down).

**CAUTION**

*Some of the procedures contain a step to press the HP 3421A's front panel switch off. Always make sure the calibration enable switch is in the up position (calibration disabled) before pressing the Model 3421A's front panel switch off or disconnect ac power. Failure to do this could cause the Calibration RAM contents to be altered, requiring complete recalibration of the instrument.*

b. Make sure the proper range and function are specified.

c. Do not specify a function that cannot be calibrated, such as F0 (all functions off) or F7 (counter).

d. Make sure the proper calibration signal is applied for the selected function and range.

e. Make sure zero calibration is performed before performing full scale (or ⅓ scale) calibration. Also make sure no reading is taken between zero and full scale calibrations.

f. Make sure the number sent to the HP 3421A for calibrating dc volts and ohms functions is within 100 counts of either one-third scale or full scale. For example, on the 3V range, the number sent must be between 2.9900 and 3.0100 for full scale calibration, or between 0.99000 and 1.01000 for ⅓ scale calibration. For ac volts, the number sent must be within 100 counts of the 3V calibration point (2.9900 - 3.0100).

g. Always wait at least 10 seconds after sending a calibration command to the HP 3421A (e.g., OUTPUT 901 ; "CO") before removing the calibration input signal or otherwise disturbing the setup. A calibration operation takes several seconds for the Model 3421A to take and average ten calibration measurements. The 10 second wait ensures proper calibration.

1-4-42. If the error indicator on the HP 3421A display turns on but none of the preceding items appear to be the cause, you can determine the cause by reading the contents of the Status, Error, Hardware Error, and Calibration Error Registers. From this you can determine what is causing the error. Do this as follows:

a. When you execute the following program line, the HP 3421A prepares a sequence of 24 numbers which are the values in the Read State Registers of the Model 3421A (see Figures 1-3-2 and 1-3-3 in Section III).

```
OUTPUT 901 ; "SR"
```

b. Since the HP 3421A errors are in the first four registers, input the contents of these registers to the controller by executing the following program line. This line places the contents of the Status Register into variable A, the Error Register into variable B, the Hardware Error Register into variable C, and the Calibration Error Register into variable D. The registers are then cleared in the Model 3421A and the display error indicator will be cleared immediately if using HP-IL, or upon by any subsequent I/O command if using HP-IB.

```
ENTER 901 ; A,B,C,D
```

c. Execute the following HP-85 commands to convert the numbers in variables A, B, C, and D from decimal to binary. The HP-85 should display a series of eight 1's and 0's for each variable. Each of these digits corresponds to one bit in the appropriate register.

Read the Status Register in variable A:

```
A$=DTB$(A)
DISP A$[9]
```

Read the Error Register in variable B:

```
A$ = DTB$(B)
DISP A$[9]
```

Read the Hardware Error Register in variable C:

```
A$ = DTB$(C)
DISP A$[9]
```

Read the Calibration Error Register in variable D:

```
A$ = DTB$(D)
DISP A$[9]
```

d. The right most digit in the HP-85 displays bit #0 with bits 1-7 numbered consecutively to the left of bit #0.

e. Use Figure 1-4-5 to identify the error condition. A condition is shown by a bit set to 1. For example, if bit 5 in Register 4 (Calibration Error Register) is a 1 (00100000), the calibration RAM is defective. If the error condition is in either Register 3 (Hardware Error Register) or in Register 4 (Calibration Error Register), go to Table 1-4-5 to determine possible causes of the error and the appropriate action.

### 1-4-43. Calibration Procedures (Manual)

1-4-44. The steps in each procedure must be performed in the order given. The equipment recommended to perform each calibration procedure is listed under that procedure. Make sure the dc volts function is properly calibrated before calibrating ac volts.

**NOTE**

*In the procedures, it is assumed that the interface select code is "9" and the device address is "01" (i.e, "901"). This is typical when using an HP-IL interface and the HP 3421A is the first device in the loop. The procedures can also be used with HP-IB if the proper interface select code and device address are specified (e.g., "709" in place of "901").*

**Register 1:** Status Register

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Always 0 | SRQ | Abnormal Condition | Low Battery | Event Occured | Self Test Error | Power-On Reset | Data Ready |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Value

**Register 2:** Error Register

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | Tried to load channel list with more than 30 channels | Can't do T3 since channel list is empty | Can't do TOT,MH, ML,MN,DT while battery is low | Option specified in command does not exist in that slot | Invalid Syntax | No data ready but addressed to talk | Triggered but F0 asserted |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Value

**Register 3:** Hardware Error Register

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| 10 Mohm test failed | RAM U503 failed | RAM U504 failed | uP RAM failed | A/D Slope Error | ROM0 checksum Error | ROM1 checksum Error | Cal RAM checksum Error |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Value

**Register 4:** Calibration Error Register

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Not Defined May be 1 or 0 | A/D Error | Cal RAM defective | Calibra-tion attempted but not enabled | Invalid Cal zero | Invalid Cal signal | Invalid Cal number | Invalid Cal function or range |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Bit Value

**Figure 1-4-5. Status, Error, Hardware Error, and Cal Error Registers**

**Table 1-4-5. Registers 3 and 4 Description**

| Register | Bit # | Description |
|---|---|---|
| 3 | 0 | Cal RAM Checksum Error.<br>This shows if any calibration RAM locations have incorrect checksums which can be caused if one or more calibration constants are missing or are invalid. If the bit is set in self test, it is typically caused by an uncalibrated Multiplexer/Actuator option. Perform the temperature calibration procedure for each option installed, as given in paragraph 1-4-59. If the bit is set when attempting the temperature calibration of the Multiplexer/Actuator option, continue with the calibration procedure. If, after calibration, the bit is still set, perform a complete instrument calibration. If after a complete calibration the bit is still set, go to Section VIII for troubleshooting. |
| | 1 | ROM1 Checksum Error.<br>This shows a ROM1 (U505) checksum error. The most likely cause is a hardware failure of the ROM itself. Go to Section VIII for troubleshooting. |
| | 2 | ROM0 Checksum Error.<br>This shows a ROM0 (U506) checksum error. The most likely cause is a hardware failure of the ROM itself. Go to Section VIII for troubleshooting. |
| | 3 | A/D Slope Error.<br>This shows an A/D slope error which can be caused by the A/D Converter itself, by an inoperative reference voltage circuitry, or the input circuitry (i.e., U102, U101, or associated circuitry). This failure could also cause bit 7 to set. Go to Section VIII for troubleshooting. |
| | 4 | Microprocessor RAM Failed.<br>This bit is set, if the RAM in the CPU (U508) is defective. Go to Section VIII for troubleshooting. |
| | 5 | RAM U504 Failed.<br>This bit is set if RAM U504 is defective. Go to Section VIII for troubleshooting. |
| | 6 | RAM U503 Failed.<br>This bit is set if RAM U503 is defective. Go to Section VIII for troubleshooting. |
| | 7 | 10 Mohm Test Failed.<br>This indicates that the 100:1 Divider (i.e., the 9.9M and 100K ohm resistors in U102) may be defective. This divider is only used on the 30V and 300V ranges. Since, during self test or at turn on, any external connections to the HP 3421A makes the divider test fail, make sure no external connections are made to the HP 3421A at turn on or while the self test is enabled. If the bit is still set with no external connections, suspect a defective U102. This bit may also be set if any part of the analog measurement circuitry to the 100:1 Divider is defective. This bit will probably be set if bit 3 (A/D Slope Error) is also set. If both bits 3 and 7 are set, the failure is most likely in the A/D Converter circuitry (go to Section VIII for troubleshooting). |
| 4 | 0 | Invalid Cal Function or Range.<br>This bit is set if the calibration constants cannot be calculated in the selected function and range. For example, If F0 (all functions off) is selected, or R-1 (.3V range) is selected with the HP 3421A in the F2 (ac volts) function, the bit will be set. Make sure the correct function and range combination is selected before attempting any calibration. |
| | 1 | Invalid Cal Number.<br>This shows that an attempt was made to calibrate the HP 3421A with an incorrect calibration number. For example, if the number for the full scale calibration signal is NOT between 299000 and 301000 or 099000 and 101000 for the ⅓ scale calibration signal, the bit will be set. Make sure the calibration signal and number are at the correct values before attempting any calibration. |
| | 2 | Invalid Cal Signal.<br>This bit is set if an attempt is made to calibrate a function and range using the wrong calibration signal. For example, the bit is set if a dc volts signal is used to calibrate the ohms function. This bit can also be set when doing the temperature calibration of the Multiplexer/Actuator option. This can happen if the HP 3421A is unable to receive a valid signal from the temperature transducer on the option. If the bit is set during temperature calibration, make sure the option's cables, associated temperature transducer, or U102 in the HP 3421A mainframe are good. If the HP 3421A has an older A1 Assembly with HP Part Number 03421-66501, suspect the temperature sensor FETs in U102. |

**Table 1-4-5. Registers 3 and 4 Description (Cont'd)**

| Register | Bit # | Description |
|---|---|---|
| 4 (cont'd) | 3 | Invalid Cal Zero. This shows that the zero calibration constant is invalid when attempting to calibrate at full or ⅓ scale. Make sure the correct zero calibration has been performed before doing any full or 1/3 scale calibration. |
| | 4 | Calibration Attempted But Not Enabled. This shows that an attempt was made to calibrate the HP 3421A with the calibration enable switch set in the disable position (S501 segment #8 in the up position). Make sure the switch is set in the calibration enable position (down) before performing any calibration. |
| | 5 | Cal RAM Defective. This shows a defective calibration RAM (U502). Go to Section VIII for troubleshooting. |
| | 6 | A/D Error. This bit is only set when an A/D error shows up during calibration. It can be caused by the A/D Converter itself, an inoperative reference voltage circuitry, or the input circuitry (i.e., U102, U101, or associated circuitry). Go to Section VIII for troubleshooting. |
| | 7 | This bit is not defined and can be either 1 or 0. |

## 1-4-45. DC Volts Calibration (Manual)

1-4-46. Table 1-4-6 lists the dc volt calibration signals. Each step in the table is shown in parenthesis in the procedure. Unless otherwise specified, calibration signals are applied to the HP 3421A Ω/V HI and Ω/V LO front panel terminals.

**Table 1-4-6. DC Volts Calibration**

| Step # | HP 3421A Input | HP 3421A Range | HP 3421A Set Up |
|---|---|---|---|
| 1 | Short | .3V | DCV Cal |
| 2 | +.3V | .3V | DCV Cal |
| 3 | Short | 3V | DCV Cal |
| 4 | +3V | 3V | DCV Cal |
| 5 | Short | 30V | DCV Cal |
| 6 | +30V | 30V | DCV Cal |
| 7 | Short | 300V | DCV Cal |
| 8 | +300V | 300V | DCV Cal |

**1-4-47. Recommended Equipment.** The following equipment is recommended to calibrate the HP 3421A for the dc volts function.

HP-85 Computer equipped with HP-IL or HP-IB
Digital Voltmeter (HP 3456A)
DC Volts Standard (Systron Donner Model M107)

**1-4-48. DC Volts Calibration Procedure.** After the HP 3421A has been turned on for one hour, do the following:

a. Disconnect all inputs to the HP 3421A front panel terminals and option assemblies HI and LO common terminals. Then RESET the Model 3421A be executing the following program line. This sets the instrument to the dc volts, 5 ½ digit mode, and opens all channels on installed option cards.

```
OUTPUT 901 ; "RS"
```

**NOTE**

*Unless all functions have calibration constants stored in the calibration RAM, the calibration RAM checksum portion of the self test will fail and cause the error indicator on the HP 3421A display to turn on. If this occurs, it is recommended that you clear the error indicator before performing the calibration procedure (see paragraph 1-4-40).*

b. Locate the rear panel calibration enable switch (S501 segment #8). Use a narrow non-conductive object to move the calibration enable switch segment down. Do not use the tip of a pencil, since graphite fragments from the pencil are conductive.

c. (Step #1) Short the HP 3421A Ω/V HI and Ω/V LO front panel terminals. Then set the instrument to the .3V range and calibrate zero by executing the following program line.

OUTPUT 901 ; "F1R-1C0"

**NOTE**

*Be sure to wait at least 10 seconds after executing this command, and all other commands in this procedure, before disturbing the equipment setup. This will ensure that the instrument has enough time to average ten readings and complete the calibration step properly.*

d. Remove the short from the HP 3421A input terminals and then set the dc volts standard for a 0V output.

e. (Step #2) Connect the HP 3421A to the digital voltmeter (DVM) and dc volts standard as shown in Figure 4-1. The DVM will be used as the standard measurement device and the dc volts standard as a stable power supply. Then do the following:

1. Set the DVM to the 1V Range with 6 digit resolution.

2. Set the dc volts standard output to .300000V and note the reading on the DVM.

3. Output the DVM reading to the HP 3421A by executing the following program line, disregarding the DVM decimal point. For example, if the DVM is displaying .300011, send "C300011".

OUTPUT 901 ; "F1R-1C300011"

f. Check the error indicator on the front panel display to make sure it is off. If it is off, the .3V range was successfully calibrated. If the error indicator is on, see paragraph 1-4-40.

g. (Step #3) Remove the DVM and dc volts standard from the HP 3421A input terminals. Short the HP 3421A input terminals and calibrate zero on the 3V range by executing the following program line.

OUTPUT 901 ; "F1R0C0"

h. (Step #4) Remove the short from the HP 3421A front panel terminals and re-connect the DVM and dc volts standard. Then do the following.

1. Set the DVM to the 10V range.

2. Set the dc volts standard for an output of 3.00000V, and note the reading on the DVM.

3. As explained for the .3V range, calibrate the HP 3421A for full scale 3V range by executing the following program line. Disregard the DVM decimal point and fill in the blanks with the DVM reading.

OUTPUT 901 ; "F1R0C__________"

i. Check the error indicator in the front panel display to make sure it is off. If it is off, the 3V range was successfully calibrated. If the error indicator is on, see paragraph 1-4-40.

j. (Step #5) Remove the DVM and dc volts standard from the HP 3421A input terminals. Short the HP 3421A input terminals and calibrate zero on the 30V range by executing the following program line.

OUTPUT 901 ; "F1R1C0"

k. (Step #6) Remove the short from the HP 3421A front panel and re-connect the DVM and dc volts standard. Then do the following.

1. Set the DVM to the 100V range.

2. Set the dc volts standard for an output of 30.0000V, and note the reading on the DVM.

3. As explained for the previous ranges, calibrate the HP 3421A for full scale 30V range by executing the following program line. Disregard the DVM decimal point and fill in the blanks with the DVM reading.

OUTPUT 901 ; "F1R1C__________"

l. Check the error indicator in the front panel display to make sure it is off. If it is off, the 30V range was successfully calibrated. If the error indicator is on, see paragraph 1-4-40.

m. (Step #7) Remove the DVM and dc volts standard from the HP 3421A input terminals. Short the HP 3421A input terminals and calibrate zero on the 300V range by executing the following program line.

OUTPUT 901 ; "F1R2C0"

n. (Step #8) Remove the short from the HP 3421A front panel and re-connect the DVM and dc volts standard. Then do the following.

1. Set the DVM to the 1000V range.

**WARNING**

*The 300V used in the next four steps (steps n.2, n.3, o, and p) is a LETHAL voltage. Do not touch the output terminals of the dc volts standard, or the input terminals of the HP 3421A or HP 3456A while performing these steps. Also, if the error indicator turns on while calibrating, set the output of the dc volts standard to 0V before clearing the error indicator and recalibrating the 300V range.*

2. Set the dc volts standard for an output of 300.000V, and note the reading on the DVM.

3. As explained for the previous ranges, calibrate the HP 3421A for full scale 300V range by executing the following program line. Disregard the DVM decimal point and fill in the blanks with the DVM reading.

OUTPUT 901 ; "F1R2C__________"

o. Check the error indicator in the front panel display to make sure it is off. If it is off, the 300V range was successfully calibrated. If it is on, first set the output of the dc volts standard to 0V and then refer to paragraph 1-4-45.

p. Set the output of the dc volts standard to 0V and then disconnect it from the HP 3421A and HP 3456A.

q. This completes the dc volts calibration. Move the calibration enable switch (S501 segment #8) to the up position, unless you are continuing on with the remainder of the calibration procedures.

### 1-4-49. AC Volts Calibration (Manual)

1-4-50. The ac volts function is calibrated using only one calibration signal: 3V RMS at 100 Hz. With the ac signal applied, the HP 3421A takes a reading in both the 3V and 30V ranges to determine the gain constants. Thus, the 3V range is a full scale measurement and the 30V range is a 1/10 scale measurement. The ranges are automatically selected by the HP 3421A during calibration.

1-4-51. Perform the ac volts calibration only after making sure the dc volts function is properly calibrated. The reason for this is because ac volt readings use both the dc volts and ac volts calibration constants. If you are not sure the dc volts function is properly calibrated, either calibrate the dc volts function first, or run the dc volts performance verification before calibrating the ac volts function.

**1-4-52. Recommended Equipment.** To perform the ac volts calibration the following equipment is recommended.

HP-85 Computer
AC Calibrator (Fluke Model 5200A)

**1-4-53. AC volts Calibration Procedure.** To calibrate the ac volts function, do the following:

a. Make sure all front panel inputs to the HP 3421A are disconnected.

b. Reset the HP 3421A by executing the following program line. This will cause the instrument to perform self test.

```
OUTPUT 901 ; "RS"
```

**NOTE**

*Be sure to wait at least 10 seconds after executing this command, and all other commands in this procedure, before disturbing the equipment setup. This ensures that the instrument has enough time to average ten readings and complete the calibration step properly.*

c. Make sure the rear panel calibration enable switch (S501 segment #8) is in the down position.

d. Set the ac calibrator to exactly 3.00000V RMS at 100 Hz.

e. Connect the ac calibrator to the HP 3421A Ω/V HI and Ω/V LO front panel terminals.

f. Calibrate the HP 3421A for the ac volts function by executing the following program line.

```
OUTPUT 901 ; "F2R0C3"
```

**NOTE**

*Be sure to wait at least 10 seconds after executing this command, and all other commands in this procedure, before disturbing the equipment setup. This ensures that the instrument has enought time to average ten readings and complete the calibration step properly.*

g. Check the error indicator in the front panel display to make sure it is off. If it is off, the ac volts function was successfully calibrated. If the error indicator is on, see paragraph 1-4-40.

h. Disconnect the ac calibrator from the HP 3421A.

i. This completes the ac volts calibration. Move the calibration enable switch (S501 segment #8) to the up position, unless you are continuing with the remaining calibration procedures.

### 1-4-54. Ohms Calibration (Manual)

1-4-55. The HP 3421A is calibrated for either the 2-wire ohms or 4-wire ohms function. It cannot be calibrated for both. Therefore, the instrument should be calibrated for the function that will be used. When calibrating for 2-wire ohms, always use leads that are the same length and have the same impedance that will be used for normal operation. This is necessary to maintain the accuracy of the ohms function.

1-4-56. The ohms function can be calibrated using either full scale or ⅓ scale inputs. The steps in parentheses in Table 1-4-7 are for the ⅓ scale calibration. It is preferable to perform calibration using full scale inputs. However, if you do not have enough precision resistors to do this, use the ⅓ scale inputs. For example, on the 300 ohm range you can use a single 100Ω precision resistor and calibrate at ⅓ scale instead of connecting three 100Ω resistors in series for a full scale calibration.

**Table 1-4-7. Ohms Calibration**

| Step # | HP 3421A Input | HP 3421A Range | HP 3421A Set-Up |
|---|---|---|---|
| 1 | Short | 300 | Ohms 2-Wire or 4-Wire |
| 2 | 300 | 300 | |
| (2) | 100 | 300 | |
| 3 | Short | 3k | |
| 4 | 3k | 3k | |
| (4) | 1k | 3k | |
| 5 | Short | 30k | |
| 6 | 30k | 30k | |
| (6) | 10k | 30k | |
| 7 | Short | 300k | |
| 8 | 300k | 300k | |
| (8) | 100k | 300k | |
| 9 | Short | 3M | |
| 10 | 3M | 3M | |
| (10) | 1M | 3M | |
| 11 | Short | 30M | |
| 12 | 30M | 30M | |
| (12) | 10M | 30M | |

**1-4-57. Recommended Equipment.** The following equipment is recommended to perform the ohms calibration.

HP-85 Computer
100Ω ±.0005% (Guildline Model 9330/100 or 9330A/100)
1kΩ ±.0005% (Guildline Model 9330/1k or 9330A/1k)
10kΩ ±.001% (Guildline Model 9330/10k or 9330A/10k)
100kΩ ±.001% (Guildline Model 9330/100k or 9330A/100k)
1MΩ ±.002% (Guildline Model 9330/1M)
10MΩ ±.01% (Guildline Model 9330/10M)

**1-4-58. Ohms Calibration Procedure.** To calibrate the HP 3421A for the ohms function (2-wire or 4-wire), do the following:

a. Make sure all front panel inputs to the HP 3421A are disconnected.

b. Reset the HP 3421A by executing the following program line. This will cause the instrument to perform self test.

OUTPUT 901 ; "RS"

c. Make sure the rear panel calibration enable switch (S501 segment #8) is in the down position.

**NOTE**

*Unless all functions have calibration constants stored in the calibration RAM, the calibration RAM checksum portion of the self test will fail and cause the error indicator in the HP 3421A display to turn on. If this occurs, it is recommended that you clear the error indicator before performing this calibration procedure (see paragraph 1-4-40).*

d. Set the HP 3421A to the 300Ω range and either the 2-wire or 4-wire ohms function by executing one of the following program lines.

2-wire ohms

OUTPUT 901 ; "F3R2"

4-wire ohms

OUTPUT 901 ; "F4R2"

e. (Step #1) Short the HP 3421A front panel input terminals. For 2-wire ohms, short the Ω/V HI and Ω/V LO terminals by shorting the end of the test leads. For 4-wire ohms, short the terminals as shown in Figure 1-4-3. Then calibrate zero for the 300Ω range by executing the following program line.

OUTPUT 901 ; "C0"

**NOTE**

*Be sure to wait at least 10 seconds after executing this command, and all other commands in this procedure, before disturbing the equipment setup. This will ensure that the calibration step is completed properly.*

f. (Step #2) Connect either the 300Ω or 100Ω standard resistance to the input terminals. For 2-wire ohms, connect the resistance across the Ω/V HI and Ω/V LO input terminals at the end of the test leads. For 4-wire ohms, connect the resistance across the sense terminals as shown in Figure 1-4-4. Then execute the following program line, depending upon the value of the resistance used.

⅓ Scale

OUTPUT 901 ; "C100000"

Full Scale

OUTPUT 901 ; "C300000"

**NOTE**

*If the exact value of the standard resistance is known, but it is slightly different than the ⅓ or full scale calibration point, you can enter the value of the resistance. Example: if the standard resistance is known to be exactly 300.025Ω, send "C300025" (disregard decimal point) for full scale calibration. Similarly, this can be done for calibrating any range where the exact resistance is known. By doing this, calibration accuracy can be improved.*

g. Check the error indicator in the HP 3421A display. If it is off, the 300Ω range was calibrated successfully. If the error indicator is on, see paragraph 1-4-40.

h. Set the HP 3421A to the 3kΩ range by executing the following program line.

OUTPUT 901 ; "R3"

i. (Step #3) Short the HP 3421A front panel input terminals. For 2-wire ohms, short the Ω/V HI and Ω/V LO terminals by shorting the end of the test leads. For 4-wire ohms, short the terminals as shown in Figure 1-4-3. Then calibrate zero for the 3kΩ range by executing the following program line.

OUTPUT 901 ; "C0"

j. (Step #4) Connect either the 3kΩ or 1kΩ standard resistance to the input terminals. For 2-wire ohms, connect the resistance across the Ω/V HI and Ω/V LO input terminals at the end of the test leads. For 4-wire ohms, connect the resistance across the sense terminals as shown in Figure 1-4-4. Then execute the following program line, depending upon the value of the resistance used.

<u>⅓ Scale</u>

OUTPUT 901 ; "C100000"

<u>Full Scale</u>

OUTPUT 901 ; "C300000"

k. Check the error indicator in the HP 3421A display. If it is off, the 3kΩ range was calibrated successfully. If the error indicator is on, see paragraph 1-4-40.

l. Set the HP 3421A to the 30kΩ range by executing the following program line.

OUTPUT 901 ; "R4"

m. (Step #5) Short the HP 3421A front panel input terminals. For 2-wire ohms, short the Ω/V HI and Ω/V LO terminals at the end of the test leads. For 4-wire ohms, short the terminals as shown in Figure 1-4-3. Then calibrate zero for the 30kΩ range by executing the following program line.

OUTPUT 901 ; "C0"

n. (Step #6) Connect either the 30kΩ or 10kΩ standard resistance to the input terminals. For 2-wire ohms, connect the resistance across the Ω/V HI and Ω/V LO at the end of the test leads. For 4-wire ohms, connect the resistance across the sense terminals as shown in Figure 1-4-4. Then execute the following program line, depending upon the value of the resistance used.

⅓ Scale

OUTPUT 901 ; "C100000"

Full Scale

OUTPUT 901 ; "C300000"

o. Check the error indicator in the HP 3421A display. If it is off, the 30kΩ range was calibrated successfully. If the error indicator is on, see paragraph 1-4-40.

p. Set the HP 3421A to the 300kΩ range by executing the following program line.

OUTPUT 901 ; "R5"

q. (Step #7) Short the HP 3421A front panel input terminals. For 2-wire ohms, short the Ω/V HI and Ω/V LO terminals at the end of the test leads. For 4-wire ohms, short the terminals as shown in Figure 1-4-3. Then calibrate zero for the 300kΩ range by executing the following program line.

OUTPUT 901 ; "C0"

r. (Step #8) Connect either the 300kΩ or 100kΩ standard resistance to the input terminals. For 2-wire ohms, connect the resistance across the Ω/V HI and Ω/V LO at the end of the test leads. For 4-wire ohms, connect the resistance across the sense terminals as shown in Figure 1-4-4. Then execute the following program line, depending upon the value of the resistance used.

⅓ Scale

OUTPUT 901 ; "C100000"

Full Scale

OUTPUT 901 ; "C300000"

s. Check the error indicator in the HP 3421A display. If it is off, the 300kΩ range was calibrated successfully. If the error indicator is on, see paragraph 1-4-40.

t. Set the HP 3421A to the 3MΩ range by executing the following program line.

OUTPUT 901 ; "R6"

u. (Step #9) Short the HP 3421A front panel input terminals. For 2-wire ohms, short the Ω/V HI and Ω/V LO terminals at the end of the test leads. For 4-wire ohms, short the terminals as shown in Figure 1-4-3. Then calibrate zero for the 3MΩ range by executing the following program line.

OUTPUT 901 ; "C0"

v. (Step #10) Connect either the 3MΩ or 1MΩ standard resistance to the input terminals. For 2-wire ohms, connect the resistance across the Ω/V HI and Ω/V LO input terminals at the end of the test leads. For 4-wire ohms, connect the resistance across the sense terminals as shown in Figure 1-4-4. Then execute the following program line, depending upon the value of the resistance used.

<u>⅓ Scale</u>

OUTPUT 901 ; "C100000"

<u>Full Scale</u>

OUTPUT 901 ; "C300000"

w. Check the error indicator in the HP 3421A display. If it is off, the 3MΩ range was calibrated successfully. If the error indicator is on, see paragraph 1-4-40.

x. Set the HP 3421A to the 30MΩ range by executing the following program line.

OUTPUT 901 ; "R7"

y. (Step #11) Short the HP 3421A front panel input terminals. For 2-wire ohms, short the Ω/V HI and Ω/V LO terminals at the end of the test leads. For 4-wire ohms, short the terminals as shown in Figure 1-4-3. Then calibrate zero for the 30MΩ range by executing the following program line.

OUTPUT 901 ; "C0"

z. (Step #12) Connect either the 30MΩ or 10MΩ standard resistance to the input terminals. For 2-wire ohms, connect the resistance across the Ω/V HI and Ω/V LO input terminals at the end of the test leads. For 4-wire ohms, connect the resistance across the sense terminals as shown in Figure 1-4-4. Then execute the following program line, depending upon the value of the resistance used.

<u>⅓ Scale</u>

OUTPUT 901 ; "C100000"

<u>Full Scale</u>

OUTPUT 901 ; "C300000"

aa. Check the error indicator in the HP 3421A display. If it is off, the 30MΩ range was calibrated successfully. If the error indicator is on, see paragraph 1-4-40.

bb. Disconnect the standard reistance from the HP 3421A input terminals.

cc. This completes the ohms calibration procedure. Set the rear panel calibration enable switch (S501 segment #8) to the up position, unless you are continuing with the remaining calibration procedures.

### 1-4-59. Temperature Calibration (Manual)

1-4-60. Temperature calibration must be performed at an ambient temperature that allows the reference junction on the Multiplexer/Actuator Assembly to be between 0°C and 69.99°C. Once the reference junction has been calibrated, the instrument should be operated at an ambient temperature within ±5°C of the temperature at which it was calibrated. Operating the instrument within this 10°C should result in a temperature measurement accuracy of ±1°C for each °C outside the range.

1-4-61. Each Multiplexer/Actuator Assembly has its own reference junction. Therefore, each assembly must be calibrated individually. The calibration should be performed after the top and rear covers are in place and there has been at least a one hour warm-up. Once a Multiplexer/Actuator Assembly is calibrated for a slot, it should be used in the slot in which it was calibrated. For example, do not calibrate two assemblies and then switch their slot locations. In addition, if a new assembly is added to the instrument, make sure it is calibrated in the slot where it will be used.

1-4-62. There are two temperature calibration procedures that can be used. One procedure uses the HP 3456A digital voltmeter and the other uses the HP 3421A internal voltmeter. The HP 3456A procedure is more convenient since the Model 3456A will automatically determine the calibration temperature. In the Model 3421A calibration procedure, the calibration temperature must be calculated by the controller using a formula given in the procedure.

1-4-63. It is recommended that the temperature calibration be performed with the HP 3421A in the same physical location position as it will be used. That is, if the Model 3421A is to be used in the vertical position, calibrate the temperature function in that position. Likewise, if the Model 3421A is to be used in the horizontal position, calibrate in that position.

**NOTE**

*The calibration RAM checksum portion of the self test will always fail if a Multiplexer Option occupies a slot that does not contain calibration constants for the temperature function.*

*The factory places 25.00°C calibration constants in RAM for all slots that are either empty or contain Digital I/O Assemblies. To ensure temperature measurement accuracy, the temperature function must be recalibrated for each field installable Multiplexer/Actuator Assembly.*

**1-4-64. Recommended Equipment.** The following equipment is recommended to calibrate the temperature function.

HP-85 Computer
Multiplexer/Actuator Assembly
Temperature Calibrator Board (HP Part Number 03421-66505)
HP 3456A Digital Voltmeter (for the HP 3456A procedure)

**NOTE**

*If there is more than one HP 44462A Multiplexer/Actuator Assembly in your instrument, you can simultaneously calibrate all the assemblies using one HP 03421-66505 Temperature Calibrator Board for each assembly instead of one board for all assemblies. If this is done, only a one hour warm-up is required for all the assemblies instead of a one hour warm-up for each individual assembly.*

**1-4-65. Temperature Calibration Procedure Using the HP 3456A.** To calibrate the temperature function using the HP 3456A, perform the following procedure. The semi-automated test and calibration procedures in paragraph 1-4-67 can be used instead of the following manual procedure, if the HP 3421A Calibration and Test Cartridge (HP Part Number 03421-10001 Rev. C or higher) is available. (Note: Only Rev. C or higher tape will operate with the Temperature Calibrator Board.)

a. Identify the slot(s) with the Multiplexer/Actuator Assembly to be calibrated (slots 0, 1, and/or 2).

**CAUTION**

*In this procedure you are directed to remove power from the HP 3421A. Always make sure the calibration enable switch (S501 segment #8) is in the up position before the Model 3421A front panel switch is pressed off or ac power is disconnected. Failure to do this could cause the calibration RAM constants to be altered requiring complete recalibration of the instrument.*

*If an HP-IL controller is used that has the "Auto Off" feature, such as is available with the HP-71B and HP-75C/D (i.e., the controller automatically turns off if not used for a certain amount of time and in turning off executes a loop power-down), make sure the controller does not turn off when connected to the HP 3421A with the calibration enable switch in the down position. If the controller turns off, the Model 3421A may unexpectedly go into the power down mode. This could also cause the calibration RAM constants to be altered requiring complete recalibration of the instrument.*

b. Make sure the rear panel calibration switch (S501 segment #8) is in the up position. Then press the HP 3421A front panel switch to the off position and unplug the instrument's power cord.

c. Remove the black rear panel strain relief bar on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.

d. Remove the grey "WARNING" safety cover(s) on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.

e. Loosen the two captive screws holding the terminal block(s) to the Multiplexer/Actuator Option board(s) and then remove the terminal block(s).

f. Plug the Temperature Calibrator Board(s) (HP P/N 03421-66505) onto the Multiplexer/Actuator Assembly (or Assemblies) to be calibrated. Make sure the component side of the calibrator board is in the up position when plugging it onto the Multiplexer/Actuator Assembly.

g. Reinstall the grey "WARNING" safety cover(s) that was/were removed in step d. This ensures a more stable temperature for calibration.

h. Plug the HP 3421A power cord into an ac outlet and press the front panel switch on.

i. Allow the HP 3421A to warm-up for at least one hour.

j. Connect the HP 3421A's HI and LO Sence Terminals, respectively. Then connect the Model 3421's HI and LO Input Terminals to the HP 3456A's HI and LO Input Terminals, respectively.

k. Place the rear panel calibration enable switch (S501 segment #8) in the down position.

l. Select channel 4 of the Multiplexer/Actuator Assembly to be calibrated by executing the following program line. Fill in the blank space with the appropriate channel number. If the Multiplexer/Actuator Assembly is in slot 0, send "CLS04". If it is in slot 1, send "CLS14". If it is in slot 2, send "CLS24".

OUTPUT 901 ; "CLS____"

m. Select the appropriate function, range, and channel by executing the following program line. Fill in the blank space with the appropriate channel number. If the Multiplexer/Actuator Assembly is in slot 0, send "REF4". If it is in slot 1, send "REF14". If it is in slot 2, send "REF24".

OUTPUT 901 ; "REF____"

n. If after sending the "REF____" command an error is detected (the HP 3421A front panel LCD error indicator is on), the error is most likely caused by an uncalibrated Multiplexer/Actuator Assembly. The error should disappear after completing the temperature calibration (step p).

o. Using the HP 3456A 2-wire ohms function and temperature math function in °C, measure and note the temperature of the thermistor on the Temperature Calibrator board. Press the following buttons on the HP 3456A to read the temperature.

2-WrΩ Function button
Auto Range button
Blue Math button on Keyboard
"6" (i.e.,THM °C) button on Keyboard

p. Execute the following program line, filling in the blank space with the HP 3456A temperature reading. The decimal point in the temperature reading is optional. However, the two leading 0's are necessary. For example, if the temperature reading is 27.95°C, send "C002795" or "C0027.95".

```
OUTPUT 901 ; "C____________"
```

**NOTE**

*Be sure to wait at least 10 seconds after executing the "C____________" command, before disturbing the equipment setup. This ensures that the instrument has enough time to average ten readings and that the calibration step has been completed properly*

q. After calibration is completed, send "REF____" again and read the results to determine if any error occurred and to observe that the temperature is within the ambient temperature range (20°C to 30°C). If the temperature is out of the specified range, try the temperature calibration again. If an error is detected, go paragraph 1-4-42 to determine what the error is. Once the error is determined, perform the appropriate action as suggested in the paragraph. To send "REF____" and read the temperature, execute the following program lines.

```
OUTPUT 901 ; "REF____"
ENTER 901 ; A
DISP A
```

r. Repeat this procedure for each slot with a Multiplexer/Actuator Assembly requiring calibration, making sure to identify the correct channel address in steps l, m, and q.

s. This completes the calibration procedure using the HP 3456A. Return the calibration enable switch (S501 segment #8) to the up position, unless you are going to perform another calibration procedure.

**1-4-66. Temperature Calibration Procedure Using the HP 3421A.** To calibrate the temperature function using the HP 3421A, perform the following procedure. The semi-automated test and calibration procedures in paragraph 1-4-67 can be used instead of the following manual procedure, if the HP 3421A Calibration and Test Cartridge (HP Part Number 03421-10001 Rev. C or higher) is available. (Note: Only Rev. C or higher tape will operate correctly with the Temperature Calibrator Board.)

a. Identify the slot(s) with the Multiplexer/Actuator Assembly to be calibrated (slots 0, 1, and/or 2).

b. Make sure the rear panel calibration switch (S501 segment #8) is in the up position. Then press the HP 3421A front panel switch to the off position and unplug the instrument's power cord.

c. Remove the black rear panel strain relief bar on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.

**CAUTION**

*In this procedure you are directed to remove power from the HP 3421A. Always make sure the calibration enable switch (S501 segment #8) is in the up position before the Model 3421A front panel switch is pressed off or ac power is disconnected. Failure to do this could cause the calibration RAM constants to be altered requiring complete recalibration of the instrument.*

*If an HP-IL controller is used that has the "Auto Off" feature, such as is available with the HP-71B and HP-75C/D (i.e., the controller automatically turns off if not used for a certain amount of time and in turning off executes a loop power-down), make sure the controller does not turn off when connected to the HP 3421A with the calibration enable switch in the down position. If the controller turns off, the Model 3421A may unexpectedly go into the power down mode. This could also cause the calibration RAM constants to be altered requiring complete recalibration of the instrument.*

d. Remove the grey "WARNING" safety cover(s) on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.

e. Loosen the two captive screws holding the terminal block(s) to the Multiplexer/Actuator Option board(s) and then remove the terminal block(s).

f. Plug the Temperature Calibrator Board(s) (HP P/N 03421-66505) onto the Multiplexer/Actuator Assembly (or Assemblies) to be calibrated. Make sure the component side of the calibrator board is in the up position when plugging it onto the Multiplexer/Actuator Assembly.

g. Reinstall the grey "WARNING" safety cover(s) that was/were removed in step d. This ensures a more stable temperature for calibration.

h. Plug the HP 3421A power cord into an ac outlet and press the front panel switch on.

i. Allow the HP 3421A to warm-up for at least one hour.

j. Key in and execute the following program. The program, as written, is setup to measure the temperature of the Multiplexer/Actuator Assembly in slot 0. To measure the temperature of the assembly in slot 1, specify "TWO14" in line 40. To measure the temperature of the assembly in slot 2, specify "TWO24" in line 40.

```
10 A = 1.285496378E-3
20 B = 2.360998857E-4
30 C = 9.324409398E-8
40 OUTPUT 901 ; "TWO4"
50 ENTER 901 ; R
60 D = 1/(A + B*LOG(R) + C*LOG(R) + UA        3)-273.16
70 D = INT(D*100 + .5)/100
80 DISP "TEMPERATURE IN DEGREES CELSIUS:";D
90 END
```

k. The HP-85 should be displaying the temperature in °C.

l. Place the rear panel calibration enable switch (S501 segment #8) in the down position.

m. Select the appropriate function, range, and channel by executing the following program line. Fill in the blank space with the appropriate channel number. If the Multiplexer/Actuator Assembly is in slot 0, send "REF4". If it is in slot 1, send "REF14". If it is in slot 2, send "REF24".

```
OUTPUT 901 ; "REF____"
```

n. If after sending the "REF____" command an error is detected (the HP 3421A front panel LCD error indicator is on), the error is most likely caused by an uncalibrated Multiplexer/Actuator Assembly. The error should disappear after completing the temperature calibration (step o).

o. Execute the following program line, filling in the blank spaces with the temperature displayed on the HP-85 (step k). The decimal point in the temperature reading is optional. However, the two leading 0's are necessary. For example, if the temperature reading is 27.95°C, send "C002795" or "C0027.95".

```
OUTPUT 901 ; "C____________"
```

**NOTE**

*Be sure to wait at least 10 seconds after executing the "C____________" command, before disturbing the equipment setup. This ensures that the instrument has enough time to average ten readings and that the calibration step has been completed properly.*

p. After calibration is completed, send "REF____" again and read the results to determine if any error occurred and to observe that the temperature is within the ambient temperature range (20°C to 30°C). If the temperature is out of the specified range, try the temperature calibration again. If an error is detected, go paragraph 1-4-42 to determine what the error is. Once the error is determined, perform the appropriate action as suggested in the paragraph. To send "REF____" and read the temperature, execute the following program lines.

```
OUTPUT 901 ; "REF____"
ENTER 901 ; A
DISP A
```

q. Repeat this procedure for each slot with a Multiplexer/Actuator Assembly requiring calibration, making sure to identify the correct channel address in steps j, m, and p.

r. This completes the calibration procedure using the HP 3421A. Return the calibration enable switch (S501 segment #8) to the up position, unless you are going to perform another calibration procedure.

## 1-4-67. SEMI-AUTOMATED TEST AND CALIBRATION PROCEDURES

1-4-68. The semi-automated test and calibration procedures require the HP 3421A Calibration and Test Tape Cartridge (HP Part Number 03421-10001 Rev. C or higher). This tape cartridge contains routines to perform the performance tests and calibration of the Model 3421A using the HP-85 computer. It also has procedures to test and calibrate the Multiplexer/Actuator Assembly, and to test the Digital I/O Assembly. The tape also includes a loop test that can be used to repeatedly exercise the Model 3421A's dc volts, ac volts, and ohms functions. This test is useful in detecting intermittent errors. The HP-85 computer is used to print a permanent record of the test results.

1-4-69. The test equipment used for the semi-automated procedures is the same as the equipment used for the manual procedures (see Table 1-4-1). One thing to keep in mind is that the Temperature Calibrator Board (HP Part Number 03421-66505) was not shipped with older HP 3421As and HP 44462As. If that is the case, use a Revision B and lower HP 3421A Calibration and Test Tape Cartridge for the temperature calibration. If the Temperature Calibrator Board is available, use a Revision C or higher tape cartridge. The semi-automated procedures leads you step-by-step with menu oriented prompts and displayed messages. This makes it faster than the manual procedures and reduces possible errors.

1-4-70. If an ac or dc source is used that is not listed in Table 1-4-1, manually set it to the appropriate output as prompted by the program.

1-4-71. The routines on the tape cartridge are intended to be self explanatory. Most responses to prompts are made with the HP-85 special functions keys. In some cases a keyboard response is required. Setup diagrams for the interconnections of the various test equipment are displayed on the HP-85. Although the figures indicate that the HP 3421A is controlled over HP-IL, it can also be controlled using HP-IB, if the appropriate HP-IB option is present. Messages will also be displayed to show when the connections are to be made and, if necessary, how to manually set the sources.

### 1-4-72. Instructions for Running the Semi-automated Procedures

1-4-73. To run the tape cartridge program, do the following:

a. With the HP-85 turned off, turn the HP 3421A on.

b. Insert the tape cartridge into the HP-85.

c. Turn the HP-85 on.

d. The program will now load which is indicated when the amber light on the HP-85 is on. After the amber light goes out, the program is loaded. Following the loading of the program, a brief period of inactivity follows. Do not strike any keys. The computer is, at that time, interpreting the BASIC program lines and will prompt when this is complete. When it is completed, the program will then run.

### 1-4-74. Special Function Keys

1-4-75. The special function keys are the major source of interaction with the program. They will determine which operation is to be performed. The bottom two lines of the HP-85 display correspond directly to the special function keys on the HP-85 keyboard. The bottom line of the display indicates the labels for the unshifted keys (K1 through K4); the upper line displays the labels for the shifted keys (K5 through K8).

### 1-4-76. Selecting Performance Tests or Calibration

1-4-77. When the program runs, the HP-85 will display information and instructions for selecting either calibration (cal) or performance verification (pv). After selecting one or the other, you will be asked if you need a copy of the equipment setup figures. After these selections are made, the proper routine (either "CAL21" or "PV21") will be loaded and prepared for execution.

**1-4-78. Performance Verification.** When the performance verification program is run, all steps should be self explanatory.

**1-4-79. Calibration.** This program initially asks for inputs that will aid in record keeping. These include the date, HP 3421A serial number, and your name. After the desired information has been entered, press the END LINE key. Next, this program asks for the HP 3421A instrument address (HP-IL or HP-IB). Again enter the requested information and press the END LINE key.

1-4-80. The next step in the calibration procedure is to set the rear panel calibration enable switch (S501 segment #8) to the enable position (down). Unless this switch is in the enable position, the CAL Switch Enable Menu will reappear in the display.

1-4-81. An uncalibrated slot will cause self test 0 to fail at power on. If this occurs, press the SKIP special function key. This will clear the error indicator.

1-4-82. When the calibration menu is displayed, make a selection using the special function keys. The calibration routine selected will request any additional information needed to perform the desired calibration.

1-4-83. At the end of any given calibration routine, you can either return to the calibration menu or exit from the calibration procedure. Once the calibration procedure is exited, the performance tests can be run by pressing the appropriate special function key.

**1-4-84. Temperature Calibration.** Temperature calibration is performed for each Multiplexer/Actuator Assembly that is installed. The temperature calibration should be performed with the HP 3421A in the same physical position in which it will be used. That is, if the HP 3421A is to be operated in the horizontal position to make temperature measurements, calibrate it in the horizontal position. If it is to be operated in the vertical position, calibrate it in the vertical position. This is necessary because of temperature gradients inside the HP 3421A case that could cause errors in temperature measurements.

**NOTE**

*The calibration RAM portion of self test will always fail if a Multiplexer Option occupies a slot that does not contain calibration constants for the temperature function.*

*The factory places 25.00 °C calibration constants in RAM for all slots, including empty slots and slots with Digital I/O Assemblies. To ensure temperature measurement accuracy, it is recommended that the temperature function be recalibrated for each installed Multiplexer Assembly when operating at temperatures other than 25 °C.*

1-4-85. An abnormal condition can cause the program to hang-up. To rerun the program, do the following:

a. Return the HP 3421A calibration enable switch (S501 segment #8) to the up position. If this is not done, the current contents of the calibration RAM could be altered.
b. Press the HP 3421A front panel switch off.
c. Press the HP-85 RESET key.
d. Press the HP 3421A front panel switch on and wait for self self test to be completed.
e. Press the HP-85 RUN key.

### 1-4-86. Temperature Sensor Verification

1-4-87. The functional operation of the reference temperature sensor of each Multiplexer/Actuator Assembly in the HP 3421A should be verified after any repair to the Model 3421A. Temperature calibration may not be necessary if the verification shows correct operation. The verification can be performed by executing a "REF" command for each Multiplexer/Actuator Assembly installed in the Model 3421A. The temperature returned should be approximately room temperature in degrees C. The following program can be used to verify the operation for the maximum number of Multiplexer/Actuator Assemblies (i.e., 3) installed. The program requires an HP-85 computer.

```
10 OUTPUT 901 ; "RS"
20 OUTPUT 901 ; "REF0"
30 ENTER 901 ; A
40 PRINT "REF TEMP FOR SLOT 0 = ";A
50 OUTPUT 901 ; REF10"
60 ENTER 901 ; A
70 PRINT "REF TEMP FOR SLOT 1 = ";A
80 OUTPUT 901 ; "REF20"
90 ENTER 901 ; A
100 PRINT "REF TEMP FOR SLOT 2 = ";A
110 OUTPUT 901 ; "RS"
120 END
```

**NOTE**

*The "RS" command in line 110 assures that the temperature sensor (on the last Multiplexer Board) is turned off. If left on over an extended period of time, internal heating of the sensor can occur. This could yield erroneous readings if/when the program is rerun.*

# SECTION V
# ADJUSTMENTS

1-5-1. This section normally contains instrument adjustment procedures. Since the Model 3421A has no adjustment procedures, there is no adjustment information in this section. There is, however, a configuration jumper used to select the proper power line voltage and 50/60Hz line rejection switch. These topics are explained in Section II of the chapter. There is also an electronic calibration procedure explained in Section IV.

# SECTION VI
# REPLACEABLE PARTS

## 1-6-1. INTRODUCTION

1-6-2. This section has information for ordering replaceable parts. Table 1-6-1 lists the abbreviations used in the parts lists. Table 1-6-2 contains the names and addresses that correspond to the part manufacturers' five digit code. Tables 1-6-3 thru 1-6-7 lists the replaceable parts in reference designator order for the 3421A mainframe and its plug-in options. The tables are separated as follows:

HP 3421A Mainframe - Table 1-6-3.
HP 44462A (Options 020, 021, and 022) - Table 1-6-4
HP 44465A (Option 050) - Table 1-6-5
HP 44461A (Option 201) - Table 1-6-6
Option 214 (Power Adapter Option) - Table 1-6-7

## 1-6-3. Replaceable Parts

1-6-4. The information listed in Tables 1-6-3 thru 1-6-7 consists of the following:

a. The HP Part Number and Check Digit.

b. The total quantity (Qty) used on the pc board and/or the total quantity used at locations other than the pc board. The total quantity for each part is given at the first appearance of the part number on the parts list.

c. The description of the part.

d. A five digit code that indicates the typical manufacturer of the part.

e. The manufacturers' part number.

## 1-6-5. ORDERING INFORMATION

1-6-6. To obtain replacement parts, address your order or inquiry to the nearest Hewlett-Packard Office. Office locations are listed at the back of this manual. Identify parts by their Hewlett-Packard Part Number. Also include instrument model and serial number.

## 1-6-7. NON-LISTED PARTS

1-6-8. To obtain a part that is not listed in Tables 1-6-3 thru 1-6-7, include the following information.

a. Instrument Model Number.
b. Instrument Serial Number.
c. Description of the part.
d. Function and location of the part.

## 1-6-9. PARTS CHANGES

1-6-10. Components which have been changed are so marked by one of three symbols; i.e., $\Delta$, $\Delta$ with a letter subscript, e.g., $\Delta a$, or $\Delta$ with a number subscript, e.g., $\Delta 10$. A $\Delta$ with no subscript indicates the component is the preferred replacement for an earlier component. A $\Delta$ with a letter subscript indicates a change which is explained at the bottom of the page. A $\Delta$ with a number subscript indicates the related change is discussed in backdating (Section VII). The number of the subscript indicates the number of the change in backdating which should be referred to.

### Table 1-6-1. Standard Abbreviations

**ABBREVIATIONS**

| | |
|---|---|
| Ag | silver |
| Al | aluminum |
| A | ampere(s) |
| Au | gold |
| C | capacitor |
| cer | ceramic |
| coef | coefficient |
| com | common |
| comp | composition |
| conn | connection |
| dep | deposited |
| DPDT | double-pole double-throw |
| DPST | double-pole single-throw |
| elect | electrolytic |
| encap | encapsulated |
| F | farad(s) |
| FET | field effect transistor |
| fxd | fixed |
| GaAs | gallium arsenide |
| GHz | gigahertz = $10^{+9}$ hertz |
| gd | guard(ed) |
| Ge | germanium |
| gnd | ground(ed) |
| H | henry(ies) |
| Hg | mercury |
| Hz | hertz (cycle(s) per second) |
| ID | inside diameter |
| impg | impregnated |
| incd | incandescent |
| ins | insulation(ed) |
| kΩ | kilohm(s) = $10^{+3}$ ohms |
| kHz | kilohertz = $10^{+3}$ hertz |
| L | inductor |
| lin | linear taper |
| log | logarithmic taper |
| mA | milliampere(s) = $10^{-3}$ amperes |
| MHZ | megahertz = $10^{+6}$ hertz |
| MΩ | megohm(s) = $10^{+6}$ ohms |
| met flm | metal film |
| mfr | manufacturer |
| ms | millisecond |
| mtg | mounting |
| mV | millivolt(s) = $10^{-3}$ volts |
| µF | microfarad(s) |
| µs | microsecond(s) |
| µV | microvolt(s) = $10^{-6}$ volts |
| my | Mylar ® |
| nA | nanoampere(s) = 10 _ g amperes |
| NC | normally closed |
| Ne | neon |
| NO | normally open |
| NPO | negative positive zero (zero temperature coefficient) |
| ns | nanosecond(s) = $10^{-9}$ seconds |
| nsr | not separately replaceable |
| Ω | ohm(s) |
| obd | order by description |
| OD | outside diameter |
| p | peak |
| pA | picoampere(s) |
| pc | printed circuit |
| pF | picofarad(s) $10^{-12}$ farads |
| piv | peak inverse voltage |
| p/o | part of |
| pos | position(s) |
| poly | polystyrene |
| pot | potentiometer |
| p-p | peak-to-peak |
| ppm | parts per million |
| prec | precision (temperature coefficient, long term stability and/or tolerance) |
| R | resistor |
| Rh | rhodium |
| rms | root-mean-square |
| rot | rotary |
| Se | selenium |
| sect | section(s) |
| Si | silicon |
| sl | slide |
| SPDT | single-pole double-throw |
| SPST | single-pole single-throw |
| Ta | tantalum |
| TC | temperature coefficient |
| $TiO_2$ | titanium dioxide |
| tog | toggle |
| tol | tolerance |
| trim | trimmer |
| TSTR | transistor |
| V | volt(s) |
| vacw | alternating current working voltage |
| var | variable |
| vdcw | direct current working voltage |
| W | watt(s) |
| w/ | with |
| wiv | working inverse voltage |
| w/o | without |
| ww | wirewound |
| * | optimum value selected at factory, average value shown (part may be omitted) |
| ** | no standard type number assigned selected or special type |

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**DESIGNATORS**

| | |
|---|---|
| A | assembly |
| B | motor |
| BT | battery |
| C | capacitor |
| CR | diode or thyristor |
| DL | delay line |
| DS | lamp |
| E | misc electronic part |
| F | fuse |
| FL | filter |
| HR | heater |
| IC | integrated circuit |
| J | jack |
| K | relay |
| L | inductor |
| M | meter |
| MP | mechanical part |
| P | plug |
| Q | transistor |
| QCR | transistor-diode |
| R(p) | resistor(pack) |
| RT | thermistor |
| S | switch |
| T | transformer |
| TB | terminal board |
| TC | thermocouple |
| TP | test point |
| TS | terminal strip |
| U | microcircuit |
| V | vacuum tube, neon bulb, photocell, etc. |
| W | cable |
| X | socket |
| XDS | lampholder |
| XF | fuseholder |
| Y | crystal |
| Z | network |

### Table 1-6-2. Code List of Manufacturers

| Mfr. No. | Manufacturer Name | Address |
|---|---|---|
| S0545 | Nippon Electric Co. | Tokyo, JP |
| 00494 | Addressograph Multigraph Corp. | Cleveland, OH 44117 |
| 00853 | Sangamo Elec. Co. S. Carolina Div. | Pickens, SC 29671 |
| 01121 | Allen-Bradley Co. | Milwaukee, WI 53204 |
| 01295 | Texas Instr. Inc. Semicond Cmpnt. Div. | Dallas, TX 75222 |
| 03888 | K D I Pyrofilm Corp. | Whippany, NJ 07981 |
| 04713 | Motorola Semiconductor Products | Phoenix, AZ 85008 |
| 06665 | Precision Monolithics, Inc. | Santa Clara, CA 95050 |
| 07263 | Fairchild Semiconductor Div. | Mountain View, CA 94042 |
| 07716 | TRW Inc. Burlington Div. | Burlington, IA 52601 |
| 09023 | Cornell-Dubilier Elek Div Fed Pac | Sanford, NC 27330 |
| 11236 | CTS of Berne Inc. | Berne, IN 46711 |
| 11502 | TRW Inc. Boone Div. | Boone, NC 28607 |
| 14936 | General Instr Corp Semicon Prod GP | Hicksville, NY 11802 |
| 19701 | Mepco/Electra Corp. | Mineral Wells, TX 76067 |
| 24546 | Corning Glass works (Bradford) | Bradford, PA 16701 |
| 27014 | National Semiconductor Corp. | Santa Clara, CA 95051 |
| 28480 | Hewlett-Packard Co. Corporate HQ | Palo Alto, CA 94304 |
| 3L585 | RCA Corp. Solid State Div. | Somerville, NJ |
| 34649 | Intel Corp. | Mountainview, CA 95051 |
| 52063 | Exar Integrated Systems Inc. | Sunnyvale, CA 94086 |
| 56289 | Sprague Electric Co. | North Adams, MA 01247 |
| 71400 | Bussman Mfg. Div. of McGraw-Edison Co. | St. Louis, MO 63107 |
| 75042 | TRW Inc. Philadelphia Div. | Philadelphia, PA 19108 |
| 75915 | Littlefuse Inc. | Des Plaines, IL 60016 |

# Table 1-6-3. HP 3421A Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A1Δ5 | 03421-66511 | 7 | 1 | MOTHERBOARD ASSEMBLY (ERC 2518) | 28480 | 03421-66511 |
| A1BT501 | 1420-0278 | 7 | 1 | BATTERY 3V .72A-HR LI/S-DIOX W-FLEX | 28480 | 1420-0278 |
| A1C101 | 0160-4438 | 6 | 2 | CAPACITOR-FXD 470PF +-2.5% 160VDC POLYP | 28480 | 0160-4438 |
| A1C102 | 0160-4438 | 6 | | CAPACITOR-FXD 470PF +-2.5% 160VDC POLYP | 28480 | 0160-4438 |
| A1C103 | 0160-4461 | 5 | 1 | CAPACITOR-FXD 150PF +-2.5% 160VDC POLYP | 28480 | 0160-4461 |
| A1C201 | 0160-3336 | 1 | 1 | CAPACITOR-FXD 100PF +-10% 50VDC CER | 28480 | 0160-3336 |
| A1C202 | 0160-4832 | 4 | 3 | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A1C203 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A1C204 | 0160-4571 | 8 | 15 | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C205Δ5 | 0170-0021 | 6 | 1 | CAPACITOR-FXD 4700PF +-10% 400VDC | 84411 | 663UW47294 |
| A1C301 | 0180-0374 | 3 | 1 | CAPACITOR-FXD 10UF +-10% 20VDC TA | 56289 | 150D106X9020B2 |
| A1C302 | 0180-0210 | 6 | 1 | CAPACITOR-FXD 3.3UF +-20% 15VDC TA | 56289 | 150D335X0015A2 |
| A1C303 | 0180-0291 | 3 | 4 | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A1C304 | 0180-0228 | 6 | 3 | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A1C305 | 0180-0228 | 6 | | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A1C401 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C402 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C404 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C405 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C406 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C410 | 0160-5392 | 3 | 1 | CAPACITOR-FXD 1500PF 400VDC | 28480 | 0160-5392 |
| A1C411 | 0160-4814 | 2 | 1 | CAPACITOR-FXD 150PF +-5% 100VDC CER | 28480 | 0160-4814 |
| A1C412 | 0160-4830 | 2 | 2 | CAPACITOR-FXD 2200PF +-10% 100VDC CER | 28480 | 0160-4830 |
| A1C430 | 0160-4823 | 3 | 1 | CAPACITOR-FXD 820PF +-5% 100VDC CER | 28480 | 0160-4823 |
| A1C431 | 0160-4832 | 4 | | CAPACITOR-FXD .01UF +-10% 100VDC CER | 28480 | 0160-4832 |
| A1C503 | 0160-4800 | 6 | 1 | CAPACITOR-FXD 120PF +-5% 100VDC CER | 28480 | 0160-4800 |
| A1C504 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C505 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C506 | 0160-4830 | 2 | | CAPACITOR-FXD 2200PF +-10% 100VDC CER | 28480 | 0160-4830 |
| A1C507 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C508 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C509 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C510 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C511 | 0160-4802 | 8 | 1 | CAPACITOR-FXD 82PF +-5% 100VDC CER 0+-30 | 28480 | 0160-4802 |
| A1C512 | 0160-4790 | 3 | 1 | CAPACITOR-FXD 12PF +-5% 100VDC CER 0+-30 | 28480 | 0160-4790 |
| A1C513 | 0180-0291 | 3 | | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A1C514 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C515 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C516 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| A1C517 | 0180-0309 | 4 | 4 | CAPACITOR-FXD 4.7UF+-20% 10VDC TA | 56289 | 150D475X0010A2 |
| A1C518Δ3 | 0160-4801 | 7 | 1 | CAPACITOR-FXD 100PF +-5% 100VDC CER | 28480 | 0160-4801 |
| A1C519Δ3 | 0160-3847 | 9 | 3 | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| A1C531 | 0180-0309 | 4 | | CAPACITOR-FXD 4.7UF+-20% 10VDC TA | 56289 | 150D475X0010A2 |
| A1C540Δ5 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| A1C581 | 0160-4835 | 7 | 1 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| A1C700 | 0180-0485 | 7 | 1 | CAPACITOR-FXD 1100UF+75-10% 40VDC AL | 07023 | UHH-1100-40 |
| A1C701 | 0180-0291 | 3 | | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A1C702 | 0180-0291 | 3 | | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| A1C703 | 0180-0197 | 8 | 5 | CAPACITOR-FXD 2.2UF+-10% 20VDC TA | 56289 | 150D225X9020A2 |
| A1C704 | 0180-0197 | 8 | | CAPACITOR-FXD 2.2UF+-10% 20VDC TA | 56289 | 150D225X9020A2 |
| A1C705 | 0160-0576 | 5 | 2 | CAPACITOR-FXD .1UF +-20% 50VDC CER | 28480 | 0160-0576 |
| A1C706 | 0180-0692 | 8 | 1 | CAPACITOR-FXD 220UF+50-10% 35VDC AL | 00494 | 35VBSL220 |
| A1C707 | 0180-0309 | 4 | | CAPACITOR-FXD 4.7UF+-20% 10VDC TA | 56289 | 150D475X0010A2 |
| A1C708 | 0180-2686 | 4 | 1 | CAPACITOR-FXD 470UF+100-10% 25VDC AL | 00853 | 301AER471U025B |
| A1C709 | 0180-0309 | 4 | | CAPACITOR-FXD 4.7UF+-20% 10VDC TA | 56289 | 150D475X0010A2 |
| A1C710 | 0180-2803 | 7 | 2 | CAPACITOR-FXD 100UF+50-10% 50VDC AL | 28480 | 0180-2803 |
| A1C711 | 0180-2803 | 7 | | CAPACITOR-FXD 100UF+50-10% 50VDC AL | 28480 | 0180-2803 |
| A1C712 | 0180-0197 | 8 | | CAPACITOR-FXD 2.2UF+-10% 20VDC TA | 56289 | 150D225X9020A2 |
| A1C713 | 0160-0127 | 2 | 4 | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C714 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C715 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C716 | 0160-0127 | 2 | | CAPACITOR-FXD 1UF +-20% 25VDC CER | 28480 | 0160-0127 |
| A1C717 | 0160-4183 | 8 | 2 | CAPACITOR-FXD 1000PF +-20% 250VAC(RMS) | 28480 | 0160-4183 |
| A1C718 | 0160-4183 | 8 | | CAPACITOR-FXD 1000PF +-20% 250VAC(RMS) | 28480 | 0160-4183 |
| A1C719 | 0160-0576 | 5 | | CAPACITOR-FXD .1UF +-20% 50VDC CER | 28480 | 0160-0576 |
| A1C720 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| A1C721Δ5 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| A1C722Δ6 | 0180-0197 | 8 | | CAPACITOR-FXD 2.2UF +-10% 20VDC TA | 56289 | 150D225X9020A2 |
| A1C723Δ6 | 0180-0197 | 8 | | CAPACITOR-FXD 2.2UF +-10% 20VDC TA | 56289 | 150D225X9020A2 |
| A1C724Δ6 | 0180-0228 | 6 | | CAPACITOR-FXD 22UF +-10% 15VDC TA | 56289 | 150D226X9015B2 |
| A1CR101 | 1901-0743 | 1 | 1 | DIODE-PWR RECT 1N4004 400V 1A DO-41 | 01295 | 1N4004 |
| A1CR201 | 1901-0849 | 8 | 1 | DIODE-PWR RECT 1N4007 1KV 1A DO-41 | 14936 | 1N4007 |
| A1CR202 | 1902-0184 | 6 | 3 | DIODE-ZNR 16.2V 5% DO-35 PD=.4W | 28480 | 1902-0184 |
| A1CR300Δ5 | 1901-0050 | 3 | 15 | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR301 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-3. HP 3421A Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A1CR302 | 1902-0959 | 3 | 2 | DIODE-ZNR 11V 5% DO-35 PD=.4W TC=+.076% | 28480 | 1902-0959 |
| A1CR303 | 1902-0959 | 3 | | DIODE-ZNR 11V 5% DO-35 PD=.4W TC=+.076% | 28480 | 1902-0959 |
| A1CR401 | 5180-0222 | 2 | 1 | IC-VR SL-63787 AGED | 28480 | 5180-0222 |
| A1CR402 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR501△5 | 1902-0951 | 5 | 2 | DIODE-ZNR 5.1V 5% DO-35 PD=.4W TC=+.035% | 28480 | 1902-0951 |
| A1CR502△5 | 1902-0951 | 5 | | DIODE-ZNR 5.1V 5% DO-35 PD=.4W TC=+.035% | 28480 | 1902-0951 |
| A1CR505 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR506 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR507 | 1902-1344 | 2 | 1 | DIODE-ZNR 4.3V 2% DO-35 PD=.25W | 28480 | 1902-1344 |
| A1CR540△5 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR541△5 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR542△5 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR543△5 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR544△5 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR545△5 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR581 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR582 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR583 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| A1CR584△6 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-34 | 28480 | 1901-0050 |
| A1CR700 | 1901-0030 | 5 | 6 | DIODE-PWR RECT 1N5393 200V 1.5A | 3L585 | 1N5393 |
| A1CR701 | 1901-0030 | 5 | | DIODE-PWR RECT 1N5393 200V 1.5A | 3L585 | 1N5393 |
| A1CR702 | 1901-0838 | 5 | | DIODE-PWR RECT 1N5393 200V 1.5A | 3L585 | 1N5393 |
| A1CR703 | 1901-0838 | 5 | | DIODE-PWR RECT 1N5393 200V 1.5A | 3L585 | 1N5393 |
| A1CR704 | 1901-0838 | 5 | | DIODE-PWR RECT 1N5393 200V 1.5A | 3L585 | 1N5393 |
| A1CR705 | 1901-0040 | 1 | 8 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A1CR706 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A1CR707 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A1CR708 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A1CR709 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A1CR710 | 1902-3054 | 5 | 1 | DIODE-ZNR 3.65V 5% DO-35 PD=.4W | 28480 | 1902-3054 |
| A1CR711 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A1CR712 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A1CR713 | 1902-1383 | 9 | 1 | DIODE-ZENER 15.5V | 28480 | 1902-1383 |
| A1CR714 | 1902-0184 | 6 | | DIODE-ZNR 16.2V 5% DO-35 PD=.4W | 28480 | 1902-0184 |
| A1CR715 | 1902-0184 | 6 | | DIODE-ZNR 16.2V 5% DO-35 PD=.4W | 28480 | 1902-0184 |
| A1CR716 | 1902-0048 | 1 | 1 | DIODE-ZNR 6.81V 5% DO-35 PD=.4W | 28480 | 1902-0048 |
| A1CR717 | 1901-0838 | 5 | | DIODE-PWR RECT 1N5393 200V 1.5A | 3L585 | 1N5393 |
| A1CR718 | 1902-0589 | 5 | 1 | DIODE-ZNR 10V 2% DO-7 PD=.4W TC=+.066% | 28480 | 1902-0589 |
| A1CR719 | 1901-0040 | 1 | | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| A1E101△12 | 1970-0100 | 9 | 1 | SURGE VOLTAGE PICTR | 28480 | 1970-0100 |
| A1E501 | 1810-0307 | 0 | 1 | NETWORK-CNDCT MODULE DIP; 16 PINS; 0.100 | 28480 | 1810-0307 |
| A1F700 | 2110-0002 | 9 | 1 | FUSE 2A 250V NTD 1.25X.25 UL | 75915 | 312002 |
| A1F701 | 2110-0320 | 4 | 1 | FUSE .15A 250V TD 1,25X.25 UL | 71400 | MDL 15/100 |
| A1FC701 | 2110-0565 | 9 | 1 | FUSEHOLDER CAP 12A MAX FOR UL | 28480 | 2110-0565 |
| A1FX700 | 2110-0643 | 4 | 1 | FUSEHOLDER-CLIP TYPE 15A 250 V | 28480 | 2110-0643 |
| A1FX701 | 2110-0642 | 3 | 1 | FUSEHOLDER-EXTR POST 6.3A 250V BAY CAP | 28480 | 2110-0642 |
| A1HS700 | 1205-0448 | 7 | 1 | HEAT SINK SGL TO-3-CS | 28480 | 1205-0448 |
| A1J100 | 1251-7857 | 3 | 3 | CONNECTOR-4-POLE MP.2 ST | 28480 | 1251-7857 |
| A1J101 | 1251-0600 | 0 | 36 | CONNECTOR-SGL CONT PIN 1.14 MM-BSC SZ SQ | 28480 | 1251-0600 |
| A1J102 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1J103 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1J104 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1J110 | 1251-7857 | 3 | | CONNECTOR-4-POLE MP.2 ST | 28480 | 1251-7857 |
| A1J120 | 1251-7857 | 3 | | CONNECTOR-4-POLE MP.2 ST | 28480 | 1251-7857 |
| A1J500 | 1200-0854 | 9 | 3 | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0854 |
| A1J501 | 1200-0854 | 9 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0854 |
| A1J502 | 1200-0854 | 9 | | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0854 |
| A1J503 | 1251-4682 | 6 | 2 | CONNECTOR 3-PIN M POST TYPE | 28480 | 1251-4682 |
| A1J504 | 1251-4682 | 6 | | CONNECTOR 3-PIN M POST TYPE | 28480 | 1251-4682 |
| A1J505 | 1251-5619 | 1 | 1 | CONNECTOR 4-PIN M POST TYPE | 28480 | 1251-5619 |
| A1J540 | 1200-0853 | 8 | 1 | SOCKET-IC 16-CONT DIP DIP-SLDR | 28480 | 1200-0853 |
| A1J700 | 1251-4743 | 0 | 1 | CONNECTOR-AC PWR HP-9 MALE REC-FLG THRMP | 28480 | 1251-4743 |
| A1J701 | 1251-5081 | 1 | 1 | CONNECTOR 2-PIN M POST TYPE | 28480 | 1251-5081 |
| A1J702△2 | 1251-7467 | 1 | 1 | CONNECTOR-SGL CONT QDISC-M .11-IN BSC-SZ | 28480 | 1251-7467 |
| A1J703 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1J704 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1J705 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1J706 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1J707 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1J708 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1JM101 | 7175-0057 | 5 | 17 | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM102 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM103 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM201 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM301 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-3. HP 3421A Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A1JM302 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM401 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM402 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM403 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM404 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM501 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM700 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM701 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM702 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM703 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM704 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM705 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM706 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1JM707 | 7175-0057 | 5 | | WIRE-REEL 22 AWG | 28480 | 7175-0057 |
| A1K101 | 0490-1336 | 6 | 4 | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| A1K102 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| A1K103 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| A1K700 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| A1L201 | 9100-1651 | 2 | 1 | INDUCTOR RF-CH-MLD 750UH 5% .2DX.45LG | 28480 | 9100-1651 |
| A1L501 | 9100-1631 | 8 | 1 | INDUCTOR RF-CH-MLD 56UH 5% .166DX.385LG | 28480 | 9100-1631 |
| A1L700 | 9100-0539 | 3 | 1 | INDUCTOR (MISC ITEM) | 28480 | 9100-0539 |
| A1P501 | 8120-3677 | 7 | 1 | CABLE ASSEMBLY-DISPLAY | 28480 | 8120-3677 |
| A1Q201 | 1853-0510 | 7 | 4 | TRANSISTOR-2N6520 (SELECTED) | 28480 | 1853-0510 |
| A1Q202 | 1853-0510 | 7 | | TRANSISTOR-2N6520 (SELECTED) | 28480 | 1853-0510 |
| A1Q203 | 1853-0510 | 7 | | TRANSISTOR-2N6520 (SELECTED) | 28480 | 1853-0510 |
| A1Q204 | 1853-0510 | 7 | | TRANSISTOR-2N6520 (SELECTED) | 28480 | 1853-0510 |
| A1Q205 | 1855-0298 | 2 | 1 | TRANSISTOR J-FET N-CHAN D-MODE TO 92 | 28480 | 1855-0298 |
| A1Q501 | 1854-0215 | 1 | 4 | TRANSISTOR NPN SI PD=350MW FT=300MHZ | 04713 | 2N3904 |
| A1Q502 | 1854-0215 | 1 | | TRANSISTOR NPN SI PD=350MW FT=300MHZ | 04713 | 2N3904 |
| A1Q503 | 1854-0215 | 1 | | TRANSISTOR NPN SI PD=350MW FT=300MHZ | 04713 | 2N3904 |
| A1Q504 | 1854-0071 | 7 | 6 | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A1Q505 | 1853-0066 | 8 | 2 | TRANSISTOR PNP SI TO-92 PD=625MW | 28480 | 1853-0066 |
| A1Q506 | 1853-0066 | 8 | | TRANSISTOR PNP SI TO-92 PD=625MW | 28480 | 1853-0066 |
| A1Q700 | 1853-0305 | 8 | 1 | TRANSISTOR PNP 2N5875 SI TO-3 PD=150W | 04713 | 2N5875 |
| A1Q701 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A1Q702 | 1853-0320 | 7 | 2 | TRANSISTOR PNP 2N4032 SI TO-5 PD=800MW | 07263 | 2N4032 |
| A1Q703 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A1Q704 | 1853-0320 | 7 | | TRANSISTOR PNP 2N4032 SI TO-5 PD=800MW | 07263 | 2N4032 |
| A1Q705 | 1854-0215 | 1 | | TRANSISTOR NPN SI PD=350MW FT=300MHZ | 04713 | 2N3904 |
| A1Q706 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A1Q707 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A1Q708Δ6 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| A1R101 | 0686-5135 | 6 | 8 | RESISTOR 51K 5% .5W CC TC=0+765 | 01121 | EB5135 |
| A1R102 | 0686-5135 | 6 | | RESISTOR 51K 5% .5W CC TC=0+765 | 01121 | EB5135 |
| A1R103 | 0686-5135 | 6 | | RESISTOR 51K 5% .5W CC TC=0+765 | 01121 | EB5135 |
| A1R104 | 0686-5135 | 6 | | RESISTOR 51K 5% .5W CC TC=0+765 | 01121 | EB5135 |
| A1R105 | 0686-5135 | 6 | | RESISTOR 51K 5% .5W CC TC=0+765 | 01121 | EB5135 |
| A1R106 | 0686-5135 | 6 | | RESISTOR 51K 5% .5W CC TC=0+765 | 01121 | EB5135 |
| A1R107 | 0698-6320 | 8 | 1 | RESISTOR 5K .1% .125W F TC=0+-25 | 03888 | PME55-1/8-T9-5001-B |
| A1R108 | 0686-5135 | 6 | | RESISTOR 51K 5% .5W CC TC=0+765 | 01121 | EB5135 |
| A1R109 | 0686-5135 | 6 | | RESISTOR 51K 5% .5W CC TC=0+765 | 01121 | EB5135 |
| A1R201 | 5180-0221 | 4 | 1 | RESISTOR 40K .1% .1W F TC=0+-5 AGED | 28480 | 5180-0221 |
| A1R202 | 0683-2445 | 9 | 2 | RESISTOR 240K 5% .25W FC TC=-800/+900 | 01121 | CB2445 |
| A1R203 | 0683-2445 | 9 | | RESISTOR 240K 5% .25W FC TC=-800/+900 | 01121 | CB2445 |
| A1R204Δ3 | 0683-4715 | 0 | 2 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A1R205 | 0683-4325 | 8 | 2 | RESISTOR 4.3K 5% .25W FC TC=-400/+700 | 01121 | CB4325 |
| A1R206Δ5 | 0683-1535 | 6 | 2 | RESISTOR 15K 5% .25W FC TC=-400/+800 | 01121 | CB1535 |
| A1R300 | 0698-4157 | 5 | 2 | RESISTOR 10K .1% .125W F TC=0+-50 | 28480 | 0698-4157 |
| A1R301 | 0698-4157 | 5 | | RESISTOR 10K .1% .125W F TC=0+-50 | 28480 | 0698-4157 |
| A1R302 | 0699-1009 | 2 | 1 | RESISTOR-FXD 25.2K OHM .1% T2 | 28480 | 0699-1009 |
| A1R303 | 0699-1008 | 1 | 1 | RESISTOR-FXD 12.6K OHM .1% T2 | 28480 | 0699-1008 |
| A1R304 | 0699-1007 | 0 | 1 | RESISTOR-FXD 8.4K OHM .1% T2 | 28480 | 0699-1007 |
| A1R305 | 0698-3258 | 5 | 1 | RESISTOR 5.36K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5361-F |
| A1R306 | 0757-0447 | 4 | 1 | RESISTOR 16.2K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1622-F |
| A1R307 | 0698-4498 | 7 | 1 | RESISTOR 53.6K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-5362-F |
| A1R308Δ4 | 0699-0832 | 7 | 1 | RESISTOR 3M 1% .125W F TC=0+-100 | 28480 | 0699-0832 |
| A1R309 | 0698-3279 | 0 | 3 | RESISTOR 4.99K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4991-F |
| A1R310 | 0698-3154 | 0 | 1 | RESISTOR 4.22K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4221-F |
| A1R401 | 0683-1655 | 1 | 1 | RESISTOR 1.6M 5% .25W FC TC=-900/+1100 | 01121 | CB1655 |
| A1R402 | 0698-8353 | 1 | 1 | RESISTOR 806K 1% .125W F TC=0+-100 | 28480 | 0698-8353 |
| A1R403 | 0698-4539 | 7 | 2 | RESISTOR 402K 1% .125W F TC=0+-100 | 28480 | 0698-4539 |
| A1R404 | 0757-0472 | 5 | 2 | RESISTOR 200K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2003-F |
| A1R405 | 0757-0465 | 6 | 2 | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1003-F |
| A1R406 | 0698-3228 | 9 | 4 | RESISTOR 49.9K 1% .125W F TC=0+-100 | 28480 | 0698-3228 |
| A1R407 | 0683-8255 | 1 | 1 | RESISTOR 8.2M 5% .25W FC TC=-900/+1100 | 01121 | CB8255 |
| A1R408 | 0683-1005 | 5 | 4 | RESISTOR 10 5% .25W FC TC=-400/+500 | 01121 | CB1005 |
| A1R409 | 0757-0415 | 6 | 1 | RESISTOR 475 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-475R-F |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-3. HP 3421A Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A1R411 | 0683-1035 | 1 | 4 | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A1R412 | 0683-1035 | 1 | | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A1R438 | 0757-0273 | 4 | 1 | RESISTOR 3.01K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3011-F |
| A1R439 | 0757-0472 | 5 | | RESISTOR 200K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-203-F |
| A1R503Δ5 | 0683-2425 | 5 | 2 | RESISTOR 2.4K 5% .25W FC TC=-400/+700 | 01121 | CB2425 |
| A1R504Δ5 | 0683-2425 | 5 | | RESISTOR 2.4K 5% .25W FC TC=-400/+700 | 01121 | CB2425 |
| A1R505 | 0683-1045 | 3 | 4 | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A1R506 | 0683-4725 | 2 | 10 | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R507 | 0698-7332 | 4 | 1 | RESISTOR 1M 1% .125W F TC=0+-100 | 28480 | 0698-7332 |
| A1R508 | 0683-3035 | 5 | 1 | RESISTOR 30K 5% .25W FC TC=-400/+800 | 01121 | CB3035 |
| A1R509 | 0683-1035 | 1 | | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A1R510 | 0683-1045 | 3 | | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A1R511 | 0683-1545 | 8 | 3 | RESISTOR 150K 5% .25W FC TC=-800/+900 | 01121 | CB1545 |
| A1R512 | 0698-8777 | 3 | 3 | RESISTOR 1K 5% .25W CC TC=-400/+900 | 28480 | 0698-8777 |
| A1R513 | 0757-0430 | 5 | 3 | RESISTOR 2.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2211-F |
| A1R514 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R516 | 0757-0430 | 5 | | RESISTOR 2.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2211-F |
| A1R517 | 0698-8777 | 3 | | RESISTOR 1K 5% .25W CC TC=-400/+900 | 28480 | 0698-8777 |
| A1R518 | 0683-3335 | 8 | 1 | RESISTOR 33K 5% .25W FC TC=-400/+800 | 01121 | CB3335 |
| A1R520 | 0757-0430 | 5 | | RESISTOR 2.21K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2211-F |
| A1R521 | 0683-1045 | 3 | | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A1R522 | 0683-1045 | 3 | | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| A1R523 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R524 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R525 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R526 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R527 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R528 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R529 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R530 | 0683-4725 | 2 | | RESISTOR 4.7K 5% .25W FC TC=-400/+700 | 01121 | CB4725 |
| A1R531 | 0757-0469 | 0 | 1 | RESISTOR 150K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1503-F |
| A1R532 | 0683-5135 | 0 | 3 | RESISTOR 51K 5% .25W FC TC=-400/+800 | 01121 | CB5135 |
| A1R533 | 0757-0465 | 6 | | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1003-F |
| A1R536 | 0683-5145 | 2 | 3 | RESISTOR 510K 5% .25W FC TC=-800/+900 | 01121 | CB5145 |
| A1R537 | 0683-5145 | 2 | | RESISTOR 510K 5% .25W FC TC=-800/+900 | 01121 | CB5145 |
| A1R538 | 0698-8777 | 3 | | RESISTOR 1K 5% .25W CC TC=-400/+900 | 28480 | 0698-8777 |
| A1R540Δ5 | 0698-4483 | 0 | 3 | RESISTOR 18.7K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1872-F |
| A1R541Δ5 | 0698-4483 | 0 | | RESISTOR 18.7K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1872-F |
| A1R542Δ5 | 0698-4483 | 0 | | RESISTOR 18.7K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1872-F |
| A1R581 | 0683-5135 | 0 | | RESISTOR 51K 5% .25W FC TC=-400/+800 | 01121 | CB5135 |
| A1R582 | 0683-1545 | 8 | | RESISTOR 150K 5% .25W FC TC=-800/+900 | 01121 | CB1545 |
| A1R583Δ5 | 0683-1535 | 6 | | RESISTOR 15K 5% .25W FC TC=-400/+800 | 01121 | CB1535 |
| A1R584Δ5 | 0683-4325 | 8 | | RESISTOR 4.3K 5% .25W FC TC=-400/+700 | 01121 | CB4325 |
| A1R585 | 0683-1545 | 8 | | RESISTOR 150K 5% .25W FC TC=-800/+900 | 01121 | CB1545 |
| A1R586 | 0683-5135 | 0 | | RESISTOR 51K 5% .25W FC TC=-400/+800 | 01121 | CB5135 |
| A1R487Δ6Δ7 | 0683-1035 | 1 | | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| A1R700 | 0757-0454 | 3 | 1 | RESISTOR 33.2K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3322-F |
| A1R701 | 0683-2015 | 9 | 1 | RESISTOR 200 5% .25W FC TC=-400/+600 | 01121 | CB2015 |
| A1R702 | 0757-0349 | 5 | 1 | RESISTOR 22.6K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2262-F |
| A1R703 | 0698-4121 | 3 | 1 | RESISTOR 11.3K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1132-F |
| A1R704 | 0757-1018 | 7 | 3 | RESISTOR 100K 1% .05W F TC=0+-100 | 19701 | MF3C1/20-T0-1003-F |
| A1R705 | 0812-0040 | 1 | 1 | RESISTOR .27 5% .5W PW TC=0+-300 | 75042 | BW20-1/2-27/100-J |
| A1R706 | 0699-0025 | 0 | 1 | RESISTOR 28.42K .25% .125W F TC=0+-50 | 28480 | 0699-0025 |
| A1R707 | 0698-6659 | 6 | 1 | RESISTOR 127K .25% .125W F TC=0+-100 | 28480 | 0698-6659 |
| A1R708 | 0698-3228 | 9 | | RESISTOR 49.9K 1% .125W F TC=0+-100 | 28480 | 0698-3228 |
| A1R709 | 0698-4523 | 9 | 1 | RESISTOR 169K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1693-F |
| A1R710 | 0757-0457 | 6 | 2 | RESISTOR 47.5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4752-F |
| A1R711 | 0757-0449 | 6 | 1 | RESISTOR 20K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2002-F |
| A1R712 | 0698-3228 | 9 | | RESISTOR 49.9K 1% .125W F TC=0+-100 | 28480 | 0698-3228 |
| A1R713 | 0698-4486 | 3 | 1 | RESISTOR 24.9K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2492-F |
| A1R714 | 0698-4473 | 8 | 1 | RESISTOR 8.06K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-8061-F |
| A1R715 | 0757-1018 | 7 | | RESISTOR 100K 1% .05W F TC=0+-100 | 19701 | MF3C1/20-T0-1003-F |
| A1R716 | 0757-0457 | 6 | | RESISTOR 47.5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4752-F |
| A1R717 | 0698-8177 | 7 | 1 | RESISTOR 1.5 5% .25W F TC=0+-100 | 11502 | TF07-1/4-T0-1R5-J |
| A1R718 | 0757-0444 | 1 | 1 | RESISTOR 12.1K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1212-F |
| A1R719 | 0757-1018 | 7 | | RESISTOR 100K 1% .05W F TC=0+-100 | 19701 | MF3C1/20-T0-1003-F |
| A1R720 | 0698-4471 | 6 | 1 | RESISTOR 7.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-7151-F |
| A1R721 | 0698-3451 | 0 | 1 | RESISTOR 133K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1333-F |
| A1R722 | 0757-0442 | 9 | 1 | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1002-F |
| A1R723 | 0698-4511 | 5 | 1 | RESISTOR 86.6K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-8662-F |
| A1R724 | 0698-4489 | 6 | 1 | RESISTOR 28K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2802-F |
| A1R725 | 0698-3161 | 9 | 1 | RESISTOR 38.3K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-3832-F |
| A1R726Δ3 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| A1R727 | 0683-1005 | 5 | | RESISTOR 10 5% .25W FC TC=-400/+500 | 01121 | CB1005 |
| A1R728 | 0698-3499 | 6 | 1 | RESISTOR 40.2K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4022-F |
| A1R729 | 0683-1005 | 5 | | RESISTOR 10 5% .25W FC TC=-400/+500 | 01121 | CB1005 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-3. HP 3421A Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A1R730 | 0698-3279 | 0 | | RESISTOR 4.99K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4991-F |
| A1R731 | 0698-3279 | 0 | | RESISTOR 4.99K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-4991-F |
| A1R732Δ5 | 0683-1005 | 5 | | RESISTOR 10 5% .25W FC TC=-400/+500 | 01121 | CB1005 |
| A1RP501 | 1810-0126 | 1 | 1 | NETWORK-RES 14-DIP10.0K OHM X 13 | 11236 | 760-1-R10K |
| A1RP502 | 1810-0201 | 3 | 1 | NETWORK-RES 14-DIP100.0K OHM X 13 | 01121 | 314A104 |
| A1RP503 | 1810-0162 | 5 | 1 | NETWORK-RES 14-DIP4.7K OHM X 13 | 11236 | 760-1-R4.7K |
| A1R733Δ6 | 0698-3228 | 9 | | RESISTOR 49.9K 1% .125W F TC=0+-100 | 28480 | 0698-3228 |
| A1R734Δ6Δ7 | 0698-4539 | 7 | | RESISTOR 402K 1% .125W F TC=0+-100 | 28480 | 0698-4539 |
| A1R735Δ6 | 0683-5145 | 2 | | RESISTOR 510K 5% .25W FC TC=-800/+900 | 01121 | CB5145 |
| A1R736Δ6 | 0698-4486 | 3 | | RESISTOR 24.9K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-2492 |
| A1RT700 | 0037-0220 | 1 | 1 | THERMISTOR ROD 10K-OHM-TC=-3.83%/C-DEG | 28480 | 0837-0220 |
| A1S501 | 3101-2243 | 6 | 1 | SWITCH-RKR DIP-RKR-ASSY 8 1A .05A 30VDC | 28480 | 3101-2243 |
| A1S502 | 3101-1299 | 0 | 1 | SWITCH-PB DPDT ALTNG .45A 115VAC | 28480 | 3101-1299 |
| A1S700 | 3101-1734 | 8 | 1 | SWITCH-PB DPDT MOM .45A 115VAC | 28480 | 3101-1734 |
| A1T501 | 9100-4275 | 2 | 1 | XFMR-HPIL TX & RCV | 28480 | 9100-4275 |
| A1T700 | 9100-4264 | 9 | 1 | TRANSFORMER-POWER | 28480 | 9100-4264 |
| A1T701 | 9100-4258 | 1 | 1 | TRANSFORMER-TORROID | 28480 | 9100-4258 |
| A1TP400 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP401 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP500 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP501 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP502 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP503 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP504 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP505 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP506 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP507 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP508 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP509 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP510 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP700 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP701 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP702 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP703 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP704 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP705 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP706 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP707 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP708 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP710 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP711 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP712 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1TP713 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| A1U101 | 1826-1056 | 1 | 1 | IC OP AMP PRCN 8-TO-99 PKG | 28480 | 1826-1056 |
| A1U102 | 1QH5-0085 | 6 | 1 | DC HYBRID | 28480 | 1QH5-0085 |
| A1U201 | 1826-0493 | 8 | 2 | IC OP AMP LOW-BIAS-H-IMPD 8-DIP-P PKG | 04713 | MLM308AP1 |
| A1U202 | 1826-0493 | 8 | | IC OP AMP LOW-BIAS-H-IMPD 8-DIP-P PKG | 04713 | MLM308AP1 |
| A1U203Δ9 | 1826-0072 | 1 | 1 | IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG | 07263 | UA208AH |
| A1U301 | 1826-0719 | 1 | 1 | IC OP AMP PRGMBL QUAD 16-DIP-C PKG | 52063 | XR346CJ |
| A1U401Δ9 | 1826-0311 | 9 | 1 | IC OP AMP GP TO-99 PKG | 01275 | LN201AN |
| A1U402 | 1826-0635 | 0 | 2 | IC OP AMP LOW-OFS 8-DIP-P PKG | 06665 | OP-07CP |
| A1U403 | 1QF6-0066 | 3 | 1 | A/D HYBRID | 28480 | 1QF6-0066 |
| A1U404 | 1826-0271 | 0 | 1 | IC OP AMP GP 8-DIP-P PKG | 01295 | SN72741P |
| A1U405 | 1826-0635 | 0 | | IC OP AMP LOW-OFS 8-DIP-P PKG | 06665 | OP-07CP |
| A1U501 | 1LB3-0003 | 8 | 1 | IC-HPIL 28 PIN | 28480 | 1LB3-0003 |
| A1U502 | 1818-1754 | 9 | 3 | IC-RAM UPD5101LC | S0545 | UPD5101LC (SELECTED) |
| A1U503 | 1818-1754 | 9 | | IC-RAM UPD5101LC | S0545 | UPD5101LC (SELECTED) |
| A1U504 | 1818-1754 | 9 | | IC-RAM UPD5101LC | S0545 | UPD5101LC (SELECTED) |
| A1U505Δ6 | 1818-3331 | 2 | 1 | IC-ROM 64K (3421A) | 28480 | 1818-3331 |
| A1U506Δ6 | 1818-3332 | 3 | 1 | IC-ROM 64K (3421A) | 28480 | 1818-3332 |
| A1U507 | 1820-2102 | 8 | 1 | IC LCH TTL LS D-TYPE OCTL | 01295 | SN74LS373N |
| A1U508 | 1820-2718 | 2 | 1 | IC-8-BIT MICROPROCESSOR WITH RAM (128X8) | 28480 | 1820-2718 |
| A1U509 | 1820-1197 | 9 | 1 | IC GATE TTL LS NAND QUAD 2-INP | 01295 | SN74LS00N |
| A1U510 | 1820-1199 | 1 | 1 | IC INV TTL LS HEX 1-INP | 01295 | SN74LS04N |
| A1U511 | 1820-2177 | 7 | 2 | IC MICPROC-ACCESS NMOS 4-BIT | 34649 | P8243 |
| A1U512 | 1820-2177 | 7 | | IC MICPROC-ACCESS NMOS 4-BIT | 34649 | P8243 |
| A1U513 | 1820-1146 | 8 | 1 | IC BFR CMOS NON-INV HEX | 3L585 | CD4050BE |
| A1U514 | 1826-0412 | 1 | 4 | IC COMPARATOR PRCN DUAL 8-DIP-P PKG | 27014 | LM393N |
| A1U531 | 1820-1745 | 3 | 1 | IC GATE CMOS NOR QUAD 2-INP | 04713 | MC14001BCP |
| A1U532 | 1820-1486 | 9 | 1 | IC GATE CMOS AND QUAD 2-INP | 3L585 | CD4081BE |
| A1U533 | 1820-0939 | 5 | 1 | IC FF CMOS D-TYPE POS-EDGE-TRIG DUAL | 3L585 | CD4013BE |
| A1U534 | 1826-0412 | 1 | | IC COMPARATOR PRCN DUAL 8-DIP-P PKG | 27014 | LM393N |
| A1U581 | 1826-0412 | 1 | | IC COMPARATOR PRCN DUAL 8-DIP-P PKG | 27014 | LM393N |
| A1U700 | 1826-0138 | 8 | 1 | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
| A1U701 | 1820-1932 | 0 | 1 | IC MV CMOS MONOSTBL RETRIG/RESET DUAL | 04713 | MC14538BCP |
| A1U702 | 1826-0412 | 1 | | IC COMPARATOR PRCN DUAL 8-DIP-P PKG | 27014 | LM393N |
| A1U703 | 1826-0774 | 8 | 1 | IC-VR LM385BZ | 28480 | 1826-0774 |
| A1VR101Δ12 | 0837-0318 | 8 | 1 | VOLTAGE SUPR | 28480 | 0837-0318 |
| A1Y501 | 0410-1332 | 4 | 1 | CRYSTAL-6.003 MHZ | 28480 | 0410-1332 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-3. HP 3421A Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| | | | | CHASSIS & MISCELLANEOUS PARTS | | |
| | | | | NOTE | | |
| | | | | REFER TO FIGURES 1-6-1 THRU 1-6-6 FOR MORE CHASSIS AND MISCELLANEOUS PARTS | | |
| | | | | MISCELLANEOUS | | |
| | 5952-8801 | 9 | 1 | APPLICATION NOTE 290 | 28480 | 5852-8801 |
| | 7175-0052 | 0 | 19 | COPPER WIRE .03IN CDA 101 | 28480 | 7175-0052 |
| | 1251-0600 | 0 | 34 | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| | 82167-60002 | 6 | 1 | HP-IL CABLE -1 METRE | 28480 | 82167-60002 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-4. HP 44462A (Options 020, 021, and 022) Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A1A1A2 | 44462-66514 | 5 | 1 | MULTIPLEXER/ACTUATOR BOARD (ERC 2417) | 28480 | 44462-66514 |
| C1 | 0160-4323 | 8 | 2 | CAPACITOR-FXD .047UF +-20% 250VAC(RMS) | C0633 | PME271M547 |
| C1 | 0160-4323 | 8 | | CAPACITOR-FXD .047UF +-20% 250VAC(RMS) | C0633 | PME271M547 |
| F1 | 2110-0010 | 9 | 2 | FUSE 5A 250V NTD 1.25X.25 UL | 75915 | 312005 |
| F2 | 2110-0010 | 9 | | FUSE 5A 250V NTD 1.25X.25 UL | 75915 | 312005 |
| FX1 | 2110-0643 | 4 | 2 | FUSEHOLDER-CLIP TYPE 15A 250 V | 28480 | 2110-0643 |
| FX2 | 2110-0643 | 4 | | FUSEHOLDER-CLIP TYPE 15A 250 V | 28480 | 2110-0643 |
| J3 | 1251-7825 | 5 | 1 | CONNECTOR | 28480 | 1251-7825 |
| J4 | 1200-0854 | 9 | 1 | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0854 |
| J5 | 1251-4682 | 6 | 3 | CONNECTOR 3-PIN M POST TYPE | 28480 | 1251-4682 |
| J6 | 1251-4682 | 6 | | CONNECTOR 3-PIN M POST TYPE | 28480 | 1251-4682 |
| J7 | 1251-4682 | 6 | | CONNECTOR 3-PIN M POST TYPE | 28480 | 1251-4682 |
| J8 | 1251-7960 | 9 | 1 | CONNECTOR 3P MP.1 HIZ | 28480 | 1251-7960 |
| K0 | 0490-1337 | 7 | 2 | RELAY-S4EB-L2-5V | 28480 | 0490-1337 |
| K1 | 0490-1337 | 7 | | RELAY-S4EB-L2-5V | 28480 | 0490-1337 |
| K2 | 0490-1336 | 6 | 8 | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| K3 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| K4 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| K5 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| K6 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| K7 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| K8 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| K9 | 0490-1336 | 6 | | RELAY-S2EB-L2-5V | 28480 | 0490-1336 |
| P6 | 1258-0141 | 8 | 3 | JUMPER-REM | 28480 | 1258-0141 |
| P7 | 1258-0141 | 8 | | JUMPER-REM | 28480 | 1258-0141 |
| P8 | 1258-0141 | 8 | | JUMPER-REM | 28480 | 1258-0141 |
| R1 | 0686-4705 | 4 | 2 | RESISTOR 47 5% .5W CC TC=0+412 | 01121 | EB4705 |
| R10 | 0686-4705 | 4 | | RESISTOR 47 5% .5W CC TC=0+412 | 01121 | EB4705 |
| R20 | 0698-6305 | 9 | 1 | RESISTOR 900K .1% .25W F TC=0+-25 | 28480 | 0698-6305 |
| R21 | 0698-7853 | 4 | 1 | RESISTOR 101.5K .1% .125W F TC=0+-50 | 19701 | MF4C1/8-T2-10152-B |
| U1 | 1820-1412 | 1 | 1 | IC DCDR CMOS BIN 2-TO-4-LINE DUAL 2-INP | 04713 | MC14556BCP |
| U2 | 1820-1962 | 6 | 3 | IC DCDR CMOS BCD-TO-DEC | 3L585 | CD4028BE |
| U3 | 1820-1962 | 6 | | IC DCDR CMOS BCD-TO-DEC | 3L585 | CD4028BE |
| U4 | 1820-1962 | 6 | | IC DCDR CMOS BCD-TO-DEC | 3L585 | CD4028BE |
| U5 | 1858-0047 | 5 | 3 | TRANSISTOR ARRAY 16-PIN PLSTC DIP | 13606 | ULN-2003A |
| U6 | 1858-0047 | 5 | | TRANSISTOR ARRAY 16-PIN PLSTC DIP | 13606 | ULN-2003A |
| U7 | 1858-0047 | 5 | | TRANSISTOR ARRAY 16-PIN PLSTC DIP | 13606 | ULN-2003A |
| U8 | 1826-0698 | 5 | 1 | IC TEMP XDCR TO-52 PKG | 24355 | AD590JH |
| VR1 | 0837-0227 | 8 | 2 | VOLTAGE SUPPRESSOR VC=730V,IP=10A | 28480 | 0837-0227 |
| VR10 | 0837-0227 | 8 | | VOLTAGE SUPPRESSOR VC=730V,IP=10A | 28480 | 0837-0227 |
| W4 | 8120-3678 | 8 | 1 | CABLE ASSEMBLY-RIBBON 14P | 28480 | 8120-3678 |
| | 03421-66505 | 9 | 1 | TEMPERATURE CALIBRATOR BOARD | 28480 | 03421-66505 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-5. HP 44465A (Option 050) Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A1Δ1 | 44465-66513 | 7 | 1 | DIGITAL I/O BOARD (ERC 2334) | 28480 | 44465-66513 |
| C1 | 0160-4822 | 2 | 1 | CAPACITOR-FXD 1000PF +-5% 100VDC CER | 28480 | 0160-4822 |
| C2 | 0160-3847 | 9 | 8 | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C3 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C4 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C5 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C6 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C7 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C8 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C9 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C10 | 0180-0291 | 3 | 2 | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| C11 | 0180-0291 | 3 | | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| CR1 | 1902-0958 | 2 | 8 | DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075% | 28480 | 1902-0958 |
| CR2 | 1902-0958 | 2 | | DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075% | 28480 | 1902-0958 |
| CR3 | 1902-0958 | 2 | | DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075% | 28480 | 1902-0958 |
| CR4 | 1902-0958 | 2 | | DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075% | 28480 | 1902-0958 |
| CR5 | 1902-0958 | 2 | | DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075% | 28480 | 1902-0958 |
| CR6 | 1902-0958 | 2 | | DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075% | 28480 | 1902-0958 |
| CR7 | 1902-0958 | 2 | | DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075% | 28480 | 1902-0958 |
| CR8 | 1902-0958 | 2 | | DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075% | 28480 | 1902-0958 |
| CR9 | 1901-0050 | 3 | 8 | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR10 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR11 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR12 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR13 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR14 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR15 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR16 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR17 | 1902-0176 | 6 | 8 | DIODE-ZNR 47V 5% PD=1W IR=5UA | 28480 | 1902-0176 |
| CR18 | 1902-0176 | 6 | | DIODE-ZNR 47V 5% PD=1W IR=5UA | 28480 | 1902-0176 |
| CR19 | 1902-0176 | 6 | | DIODE-ZNR 47V 5% PD=1W IR=5UA | 28480 | 1902-0176 |
| CR20 | 1902-0176 | 6 | | DIODE-ZNR 47V 5% PD=1W IR=5UA | 28480 | 1902-0176 |
| CR21 | 1902-0176 | 6 | | DIODE-ZNR 47V 5% PD=1W IR=5UA | 28480 | 1902-0176 |
| CR22 | 1902-0176 | 6 | | DIODE-ZNR 47V 5% PD=1W IR=5UA | 28480 | 1902-0176 |
| CR23 | 1902-0176 | 6 | | DIODE-ZNR 47V 5% PD=1W IR=5UA | 28480 | 1902-0176 |
| CR24 | 1902-0176 | 6 | | DIODE-ZNR 47V 5% PD=1W IR=5UA | 28480 | 1902-0176 |
| CR25 | 1902-0554 | 4 | 8 | DIODE-ZNR 10V 5% PD=1W IR=10UA | 28480 | 1902-0554 |
| CR26 | 1902-0554 | 4 | | DIODE-ZNR 10V 5% PD=1W IR=10UA | 28480 | 1902-0554 |
| CR27 | 1902-0554 | 4 | | DIODE-ZNR 10V 5% PD=1W IR=10UA | 28480 | 1902-0554 |
| CR28 | 1902-0554 | 4 | | DIODE-ZNR 10V 5% PD=1W IR=10UA | 28480 | 1902-0554 |
| CR29 | 1902-0554 | 4 | | DIODE-ZNR 10V 5% PD=1W IR=10UA | 28480 | 1902-0554 |
| CR30 | 1902-0554 | 4 | | DIODE-ZNR 10V 5% PD=1W IR=10UA | 28480 | 1902-0554 |
| CR31 | 1902-0554 | 4 | | DIODE-ZNR 10V 5% PD=1W IR=10UA | 28480 | 1902-0554 |
| CR32 | 1902-0554 | 4 | | DIODE-ZNR 10V 5% PD=1W IR=10UA | 28480 | 1902-0554 |
| J4 | 1200-0854 | 9 | 1 | SOCKET-IC 14-CONT DIP DIP-SLDR | 28480 | 1200-0854 |
| Q1 | 1855-0489 | 3 | 8 | VMOS IVN5201 TNF | 28480 | 1855-0489 |
| Q2 | 1855-0489 | 3 | | VMOS IVN5201 TNF | 28480 | 1855-0489 |
| Q3 | 1855-0489 | 3 | | VMOS IVN5201 TNF | 28480 | 1855-0489 |
| Q4 | 1855-0489 | 3 | | VMOS IVN5201 TNF | 28480 | 1855-0489 |
| Q5 | 1855-0489 | 3 | | VMOS IVN5201 TNF | 28480 | 1855-0489 |
| Q6 | 1855-0489 | 3 | | VMOS IVN5201 TNF | 28480 | 1855-0489 |
| Q7 | 1855-0489 | 3 | | VMOS IVN5201 TNF | 28480 | 1855-0489 |
| Q8 | 1855-0489 | 3 | | VMOS IVN5201 TNF | 28480 | 1855-0489 |
| Q9 | 1854-0087 | 5 | 16 | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q10 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q11 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q12 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q13 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q14 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q15 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q16 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q17 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q18 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q19 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q20 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q21 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q22 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q23 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |
| Q24 | 1854-0087 | 5 | | TRANSISTOR NPN SI PD=360MW FT=75MHZ | 28480 | 1854-0087 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-5. HP 44465A (Option 050) Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| R2 | 0757-0468 | 9 | 1 | RESISTOR 130K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-1303-F |
| R3 | 0698-4471 | 6 | 1 | RESISTOR 7.15K 1% .125W F TC=0+-100 | 24546 | C4-1/8-T0-7151-F |
| R4 | 0683-3625 | 9 | 8 | RESISTOR 3.6K 5% .25W FC TC=-400/+700 | 01121 | CB3625 |
| R5 | 0683-4715 | 0 | 8 | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| R6 | 0683-2055 | 7 | 8 | RESISTOR 2M 5% .25W FC TC=-900/+1100 | 01121 | CB2055 |
| R7 | 0683-2055 | 7 | | RESISTOR 2M 5% .25W FC TC=-900/+1100 | 01121 | CB2055 |
| R8 | 0683-2055 | 7 | | RESISTOR 2M 5% .25W FC TC=-900/+1100 | 01121 | CB2055 |
| R9 | 0683-2055 | 7 | | RESISTOR 2M 5% .25W FC TC=-900/+1100 | 01121 | CB2055 |
| R10 | 0683-2055 | 7 | | RESISTOR 2M 5% .25W FC TC=-900/+1100 | 01121 | CB2055 |
| R11 | 0683-2055 | 7 | | RESISTOR 2M 5% .25W FC TC=-900/+1100 | 01121 | CB2055 |
| R12 | 0683-2055 | 7 | | RESISTOR 2M 5% .25W FC TC=-900/+1100 | 01121 | CB2055 |
| R13 | 0683-2055 | 7 | | RESISTOR 2M 5% .25W FC TC=-900/+1100 | 01121 | CB2055 |
| R15 | 0683-3915 | 0 | 8 | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| R16 | 0683-3915 | 0 | | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| R17 | 0683-3915 | 0 | | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| R18 | 0683-3915 | 0 | | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| R19 | 0683-3915 | 0 | | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| R20 | 0683-3915 | 0 | | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| R21 | 0683-3915 | 0 | | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| R22 | 0683-3915 | 0 | | RESISTOR 390 5% .25W FC TC=-400/+600 | 01121 | CB3915 |
| R23 | 0686-1025 | 5 | 8 | RESISTOR 1K 5% .5W CC TC=0+647 | 01121 | EB1025 |
| R24 | 0686-1025 | 5 | | RESISTOR 1K 5% .5W CC TC=0+647 | 01121 | EB1025 |
| R25 | 0686-1025 | 5 | | RESISTOR 1K 5% .5W CC TC=0+647 | 01121 | EB1025 |
| R26 | 0686-1025 | 5 | | RESISTOR 1K 5% .5W CC TC=0+647 | 01121 | EB1025 |
| R27 | 0686-1025 | 5 | | RESISTOR 1K 5% .5W CC TC=0+647 | 01121 | EB1025 |
| R28 | 0686-1025 | 5 | | RESISTOR 1K 5% .5W CC TC=0+647 | 01121 | EB1025 |
| R29 | 0686-1025 | 5 | | RESISTOR 1K 5% .5W CC TC=0+647 | 01121 | EB1025 |
| R30 | 0686-1025 | 5 | | RESISTOR 1K 5% .5W CC TC=0+647 | 01121 | EB1025 |
| R32 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| R33 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| R34 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| R35 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| R36 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| R37 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| R38 | 0683-4715 | 0 | | RESISTOR 470 5% .25W FC TC=-400/+600 | 01121 | CB4715 |
| R39 | 0683-3625 | 9 | | RESISTOR 3.6K 5% .25W FC TC=-400/+700 | 01121 | CB3625 |
| R40 | 0683-3625 | 9 | | RESISTOR 3.6K 5% .25W FC TC=-400/+700 | 01121 | CB3625 |
| R41 | 0683-3625 | 9 | | RESISTOR 3.6K 5% .25W FC TC=-400/+700 | 01121 | CB3625 |
| R42 | 0683-3625 | 9 | | RESISTOR 3.6K 5% .25W FC TC=-400/+700 | 01121 | CB3625 |
| R43 | 0683-3625 | 9 | | RESISTOR 3.6K 5% .25W FC TC=-400/+700 | 01121 | CB3625 |
| R44 | 0683-3625 | 9 | | RESISTOR 3.6K 5% .25W FC TC=-400/+700 | 01121 | CB3625 |
| R45 | 0683-3625 | 9 | | RESISTOR 3.6K 5% .25W FC TC=-400/+700 | 01121 | CB3625 |
| RP1 | 1810-0281 | 9 | 2 | NETWORK-RES 10-SIP100.0K OHM X 9 | 01121 | 210A104 |
| RP14 | 1810-0269 | 3 | 1 | NETWORK-RES 9-SIP10.0K OHM X 8 | 28480 | 1810-0269 |
| RP31 | 1810-0281 | 9 | | NETWORK-RES 10-SIP100.0K OHM X 9 | 01121 | 210A104 |
| T1 | 9100-4131 | 9 | 2 | TRANSFORMER-PULSE QUAD; 22 PIN MODIFIED | 28480 | 9100-4131 |
| T2 | 9100-4131 | 9 | | TRANSFORMER-PULSE QUAD; 22 PIN MODIFIED | 28480 | 9100-4131 |
| U1 | 1820-2232 | 5 | 1 | IC RGTR CMOS 8-BIT | 04713 | MC14034BCP |
| U2 | 1820-2215 | 4 | 1 | IC LCH CMOS OCTL | 27014 | MM74C373N |
| U3 | 1820-2538 | 4 | 1 | IC DRVR CMOS LINE DRVR OCTL | 27014 | MM74C240N |
| U4 | 1820-2537 | 3 | 1 | IC DRVR CMOS LINE DRVR OCTL | 27014 | MM74C244N |
| U5 | 1820-1746 | 4 | 1 | IC BFR CMOS INV HEX | 04713 | MC14049UBCP |
| U6 | 1820-2466 | 7 | 1 | IC TIMER CMOS | 32293 | ICM7555IPA |
| U7 | 1820-1486 | 9 | 2 | IC GATE CMOS AND QUAD 2-INP | 3L585 | CD4081BE |
| U8 | 1820-1486 | 9 | | IC GATE CMOS AND QUAD 2-INP | 3L585 | CD4081BE |
| U11 | 1990-0545 | 8 | 8 | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA-MAX | 28480 | 5082-4371 |
| U12 | 1990-0545 | 8 | | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA-MAX | 28480 | 5082-4371 |
| U13 | 1990-0545 | 8 | | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA-MAX | 28480 | 5082-4371 |
| U14 | 1990-0545 | 8 | | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA-MAX | 28480 | 5082-4371 |
| U15 | 1990-0545 | 8 | | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA-MAX | 28480 | 5082-4371 |
| U16 | 1990-0545 | 8 | | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA-MAX | 28480 | 5082-4371 |
| U17 | 1990-0545 | 8 | | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA-MAX | 28480 | 5082-4371 |
| U18 | 1990-0545 | 8 | | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA-MAX | 28480 | 5082-4371 |
| VR1 | 0837-0196 | 0 | 20 | SUPPR-V 430V | 28480 | 0837-0196 |
| VR2 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR3 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR4 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR5 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR6 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR7 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR8 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR9 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR10 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-5. HP 44465A (Option 050) Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| VR11 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR12 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR13 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR14 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR15 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR16 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR17 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR18 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR19 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| VR20 | 0837-0196 | 0 | | SUPPR-V 430V | 28480 | 0837-0196 |
| W4 | 8120-3678 | 8 | 1 | CABLE ASSEMBLY-RIBBON 14P | 28480 | 8120-3678 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-6. HP 44461A (Option 201) Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A1 | 44461-66502 | 6 | 1 | HP-IB BOARD (ERC 2420) | 28480 | 44461-66502 |
| C801 | 0180-0291 | 3 | 3 | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| C802 | 0180-0061 | 5 | 2 | CAPACITOR-FXD 100UF+75-10% 16VDC AL | 56289 | 30D107G016DC2 |
| C803 | 0180-0309 | 4 | 1 | CAPACITOR-FXD 4.7UF+-20% 10VDC TA | 56289 | 150D475X0010A2 |
| C804 | 0180-0291 | 3 | | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| C805 | 0180-0061 | 5 | | CAPACITOR-FXD 100UF+75-10% 16VDC AL | 56289 | 30D107G016DC2 |
| C806 | 0160-3847 | 9 | 17 | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C807 | 0160-4835 | 7 | 1 | CAPACITOR-FXD .1UF +-10% 50VDC CER | 28480 | 0160-4835 |
| C808 | 0160-4800 | 6 | 1 | CAPACITOR-FXD 120PF +-5% 100VDC CER | 28480 | 0160-4800 |
| C809 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C810 | 0180-0291 | 3 | | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| C811 | 0160-4807 | 3 | 2 | CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30 | 28480 | 0160-4807 |
| C812 | 0160-4807 | 3 | | CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30 | 28480 | 0160-4807 |
| C813 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C814 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C815 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C816 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C817 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C818 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C819 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C820 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C821 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C822 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C823 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C824 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C825 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C826 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| C827 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER | 28480 | 0160-3847 |
| CR801 | 1901-0050 | 3 | 22 | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR802 | 1901-1080 | 1 | 1 | DIODE-SCHOTTKY 1N5817 20V 1A | 04713 | 1N5817 |
| CR803 | 1902-0983 | 3 | 1 | DIODE-ZNR 1N4621 3.6V 5% DO-14 PD=.25W | 01281 | 1N4621 |
| CR804 | 1902-0953 | 7 | 1 | DIODE-ZNR 6.2V 5% DO-35 PD=.4W TC=+.053% | 28480 | 1902-0953 |
| CR805 | 1910-0016 | 0 | 2 | DIODE-GE 604 60MA | 28480 | 1910-0016 |
| CR806 | 1910-0016 | 0 | | DIODE-GE 60V 60MA | 28480 | 1910-0016 |
| CR807 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR808 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR809 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR810 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR811 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR812 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR813 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR814 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR815 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR816 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR817 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR818 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR819 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR820 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR821 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR822 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR823 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR824 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR825 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR826 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR827 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| J801 | 1251-4335 | 6 | 1 | CONNECTOR 8-PIN M POST TYPE | 28480 | 1251-4335 |
| J802 | 1251-0600 | 0 | 1 | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| J803 | 1251-5081 | 1 | 1 | CONNECTOR 2-PIN M POST TYPE | 28480 | 1251-5081 |
| J804 | 1251-5619 | 1 | 2 | CONNECTOR 4-PIN M POST TYPE | 28480 | 1251-5619 |
| J805 | 1251-5619 | 1 | | CONNECTOR 4-PIN M POST TYPE | 28480 | 1251-5619 |
| J806 | 1251-5529 | 2 | 1 | CONNECTOR 24-PIN F AMP CHAMP | 28480 | 1251-5529 |
| L801 | 9100-0539 | 3 | 1 | INDUCTOR (MISC ITEM) | 28480 | 9100-0539 |
| L802 | 9100-1631 | 8 | 1 | INDUCTOR RF-CH-MLD 56UH 5% .166DX.385LG | 28480 | 9100-1631 |
| L803 | 9170-0894 | 0 | 1 | CORE-SHIELDING BEAD | 28480 | 9170-0894 |
| MP1 | 0340-1067 | 3 | 1 | INS-HT SHLD | 28480 | 0340-1067 |
| MP2 | 03421-00606 | 3 | 1 | SHLD-LEXAN HPIB | 28480 | 03421-00606 |
| MP3 | 03421-04101 | 1 | 1 | CVR-HPIB, SSCRN'D | 28480 | 03421-04101 |
| MP4 | 03421-62101 | 3 | 1 | CONN-ASSY HPIL | 28480 | 03421-62101 |
| MP5 | 03421-64102 | 8 | 1 | HPIB-COVER ASSY | 28480 | 03421-64102 |
| MP6 | 03421-64107 | 0 | 1 | PLATE-MTG HPIB | 28480 | 03421-64107 |
| MP8 | 0515-0211 | 8 | 1 | SCREW-MACH M3 X 0.5 6MM-LG PAN-HD | 00000 | ORDER BY DESCRIPTION |
| MP9 | 0624-0023 | 1 | 1 | SCREW-TPG 4-40 .25-IN-LG PAN-HD-PHL | 00000 | ORDER BY DESCRIPTION |
| MP10 | 1390-0626 | 4 | 1 | SCREW-CAPTIVE M3.0 X 10 | 28480 | 1390-0626 |
| MP11 | 1600-1172 | 4 | 1 | STPG-SS PIL CLIP | 28480 | 1600-1172 |
| Q801 | 1853-0320 | 7 | 1 | TRANSISTOR PNP 2N4032 SI TO-5 PD=800MW | 07263 | 2N4032 |
| Q802 | 1854-0071 | 7 | 1 | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-6. HP 44461A (Option 201) Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| R801 | 0683-4735 | 4 | 1 | RESISTOR 47K 5% .25W FC TC=-400/+800 | 01121 | CB4735 |
| R802 | 0683-1015 | 7 | 2 | RESISTOR 100 5% .25W FC TC=-400/+500 | 01121 | CB1015 |
| R803 | 0698-4424 | 9 | 1 | RESISTOR 1.4K 1% .125W FC TC=-400/+700 | 01121 | CB4725 |
| R804 | 0683-1005 | 5 | 1 | RESISTOR 10 5% .25W FC TC=-400/+500 | 01121 | CB1005 |
| R805 | 0683-2715 | 6 | 2 | RESISTOR 270 5% .25W FC TC=-400/+600 | 01121 | CB2715 |
| R806 | 0683-2715 | 6 | | RESISTOR 270 5% .25W FC TC=-400/+600 | 01121 | CB2715 |
| R807 | 0683-1315 | 0 | 2 | RESISTOR 130 5% .25W FC TC=-400/+600 | 01121 | CB1315 |
| R808 | 0683-1315 | 0 | | RESISTOR 130 5% .25W FC TC=-400/+600 | 01121 | CB1315 |
| R809 | 0683-1025 | 9 | 2 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| R810 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| R811 | 0683-1015 | 7 | | RESISTOR 100 5% .25W FC TC=-400/+500 | 01121 | CB1015 |
| R812 | 0683-1825 | 7 | 2 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB1825 |
| R813 | 0683-3325 | 6 | 3 | RESISTOR 3.3K 5% .25W FC TC=-400/+700 | 01121 | CB3325 |
| R814 | 0683-2225 | 3 | 5 | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| R815 | 0683-6825 | 7 | 20 | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R816 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R817 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R818 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R819 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R820 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R821 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R822 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R823 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R824 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R825 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R826 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R827 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R828 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R829 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R830 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R831 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R832 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R833 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R834 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R835 | 0683-3325 | 6 | | RESISTOR 3.3K 5% .25W FC TC=-400/+700 | 01121 | CB3325 |
| R836 | 0683- 1825 | 7 | 1 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB 1825 |
| R837 | 0683-1035 | 1 | 3 | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| R838 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| R839 | 0683-3325 | 6 | | RESISTOR 3.3K 5% .25W FC TC=-400/+700 | 01121 | CB3325 |
| R840 | 0683-1035 | 1 | | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| R841 | 0683-1035 | 1 | | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| R842 | 0683-1045 | 3 | 1 | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| R843 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| R844 | 0683-0275 | 9 | 1 | RESISTOR 2.7 5% .25W FC TC=-400/+500 | 01121 | CB0275 |
| R845 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| R846 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| RP801 | 1810-0126 | 1 | 2 | NETWORK-RES 14-DIP10.0K OHM X 13 | 11236 | 760-1-R10K |
| RP802 | 1810-0126 | 1 | | NETWORK-RES 14-DIP10.0K OHM X 13 | 11236 | 760-1-R10K |
| RP803 | 1810-0190 | 9 | 1 | NETWORK-RES 14-DIP2.2K OHM X 13 | 01121 | 314A222 |
| RP804 | 1810-0122 | 7 | 1 | NETWORK-RES 14-DIP3.3K OHM X 13 | 01121 | 314A332 |
| S801 | 3101-1928 | 2 | 1 | SWITCH-PB 6PDT ALTNG 4A 250VAC | 28480 | 3101-1928 |
| S802 | 3101-2243 | 6 | 1 | SWITCH-RKR DIP-RKR-ASSY 8-1A .05A 30VDC | 28480 | 3101-2243 |
| T801 | 9100-2686 | 5 | 1 | XFMR HPIB | 28480 | 9100-2686 |
| U801 | 1990-0545 | 8 | 1 | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA MAX | 28480 | 5082-4371 |
| U802 | 1826-0138 | 8 | 1 | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
| U803 | 1LB3-0003 | 8 | 1 | IC HPIL 28 PIN | 28480 | 1LB3-0003 |
| U804 | 1820-3428 | 3 | 1 | IC MASKED 8048 | 28480 | 1820-3428 |
| U805 | 1820-1412 | 1 | 1 | IC DCDR CMOS BIN 2-TO-4-LINE DUAL 2-INP | 04713 | MC14556BCP |
| U806 | 1820-2537 | 3 | 3 | IC DRVR CMOS LINE DRVR OCTL | 27014 | MM74C244N |
| U807 | 1820-2537 | 3 | | IC DRVR CMOS LINE DRVR OCTL | 27014 | MM74C244N |
| U808 | 1820-2537 | 3 | | IC DRVR CMOS LINE DRVR OCTL | 27014 | MM74C244N |
| U809 | 1820-2216 | 5 | 1 | IC FF CMOS D-TYPE POS-EDGE-TRIG OCTL | 27014 | MM74C374N |
| U810 | 1820-1578 | 0 | 2 | IC SHF-RGTR CMOS D-TYPE PRL-IN PRL-OUT | 3L585 | CD4076BE |
| U811 | 1820-1578 | 0 | | IC SHF-RGTR CMOS D-TYPE PRL-IN PRL-OUT | 3L585 | CD4076BE |
| U812 | 1820-1416 | 5 | 3 | IC SCHMITT-TRIG TTL LS INV HEX 1-INP | 01295 | SN74LS14N |
| U813 | 1820-1416 | 5 | | IC SCHMITT-TRIG TTL LS INV HEX 1-INP | 01295 | SN74LS14N |
| U814 | 1820-1416 | 5 | | IC SCHMITT-TRIG TTL LS INV HEX 1-INP | 01295 | SN74LS14N |
| U815 | 1820-1746 | 4 | 1 | IC BFR CMOS INV HEX | 04713 | MC14049UBCP |
| U816 | 1820-1747 | 5 | 1 | IC GATE CMOS NAND QUAD 2-INP | 04713 | MC14011BCP |
| U817 | 1820-1745 | 3 | 1 | IC GATE CMOS NOR QUAD 2-INP | 04713 | MC14001BCP |
| U818 | 1858-0044 | 2 | 3 | XSTR-ARY | 28480 | 1858-0044 |
| U819 | 1858-0044 | 2 | | XSTR-ARY | 28480 | 1858-0044 |
| U820 | 1858-0044 | 2 | | XSTR-ARY | 28480 | 1858-0044 |
| W803 | 1251-0689 | 5 | 1 | CONNECTOR 2-PIN F POST TYPE | 28480 | 1251-0689 |
| W804 | 1251-3483 | 3 | 2 | CONNECTOR 4-PIN F POST TYPE | 28480 | 1251-3483 |
| W805 | 1251-3483 | 3 | | CONNECTOR 4-PIN F POST TYPE | 28480 | 1251-3483 |
| Y801 | 0410-1332 | 4 | 1 | CRYSTAL-6.003 MHZ | 28480 | 0410-1332 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-6. HP 44461A (Option 201) Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| R801 | 0683-4735 | 4 | 1 | RESISTOR 47K 5% .25W FC TC=-400/+800 | 01121 | CB4735 |
| R802 | 0683-1015 | 7 | 2 | RESISTOR 100 5% .25W FC TC=-400/+500 | 01121 | CB1015 |
| R803 | 0698-4424 | 9 | 1 | RESISTOR 1.4K 1% .125W FC TC=-400/+700 | 01121 | CB4725 |
| R804 | 0683-1005 | 5 | 1 | RESISTOR 10 5% .25W FC TC=-400/+500 | 01121 | CB1005 |
| R805 | 0683-2715 | 6 | 2 | RESISTOR 270 5% .25W FC TC=-400/+600 | 01121 | CB2715 |
| R806 | 0683-2715 | 6 | | RESISTOR 270 5% .25W FC TC=-400/+600 | 01121 | CB2715 |
| R807 | 0683-1315 | 0 | 2 | RESISTOR 130 5% .25W FC TC=-400/+600 | 01121 | CB1315 |
| R808 | 0683-1315 | 0 | | RESISTOR 130 5% .25W FC TC=-400/+600 | 01121 | CB1315 |
| R809 | 0683-1025 | 9 | 2 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| R810 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| R811 | 0683-1015 | 7 | | RESISTOR 100 5% .25W FC TC=-400/+500 | 01121 | CB1015 |
| R812 | 0683-1825 | 7 | 2 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB1825 |
| R813 | 0683-3325 | 6 | 3 | RESISTOR 3.3K 5% .25W FC TC=-400/+700 | 01121 | CB3325 |
| R814 | 0683-2225 | 3 | 5 | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| R815 | 0683-6825 | 7 | 20 | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R816 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R817 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R818 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R819 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R820 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R821 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R822 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R823 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R824 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R825 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R826 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R827 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R828 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R829 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R830 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R831 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R832 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R833 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R834 | 0683-6825 | 7 | | RESISTOR 6.8K 5% .25W FC TC=-400/+700 | 01121 | CB6825 |
| R835 | 0683-3325 | 6 | | RESISTOR 3.3K 5% .25W FC TC=-400/+700 | 01121 | CB3325 |
| R836 | 0683- 1825 | 7 | 1 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 | 01121 | CB 1825 |
| R837 | 0683-1035 | 1 | 3 | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| R838 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| R839 | 0683-3325 | 6 | | RESISTOR 3.3K 5% .25W FC TC=-400/+700 | 01121 | CB3325 |
| R840 | 0683-1035 | 1 | | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| R841 | 0683-1035 | 1 | | RESISTOR 10K 5% .25W FC TC=-400/+700 | 01121 | CB1035 |
| R842 | 0683-1045 | 3 | 1 | RESISTOR 100K 5% .25W FC TC=-400/+800 | 01121 | CB1045 |
| R843 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| R844 | 0683-0275 | 9 | 1 | RESISTOR 2.7 5% .25W FC TC=-400/+500 | 01121 | CB0275 |
| R845 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| R846 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 | 01121 | CB2225 |
| RP801 | 1810-0126 | 1 | 2 | NETWORK-RES 14-DIP10.0K OHM X 13 | 11236 | 760-1-R10K |
| RP802 | 1810-0126 | 1 | | NETWORK-RES 14-DIP10.0K OHM X 13 | 11236 | 760-1-R10K |
| RP803 | 1810-0190 | 9 | 1 | NETWORK-RES 14-DIP2.2K OHM X 13 | 01121 | 314A222 |
| RP804 | 1810-0122 | 7 | 1 | NETWORK-RES 14-DIP3.3K OHM X 13 | 01121 | 314A332 |
| S801 | 3101-1928 | 2 | 1 | SWITCH-PB 6PDT ALTNG 4A 250VAC | 28480 | 3101-1928 |
| S802 | 3101-2243 | 6 | 1 | SWITCH-RKR DIP-RKR-ASSY 8-1A .05A 30VDC | 28480 | 3101-2243 |
| T801 | 9100-2686 | 5 | 1 | XFMR HPIB | 28480 | 9100-2686 |
| U801 | 1990-0545 | 8 | 1 | OPTO-ISOLATOR LED-PDIO/XSTR IF=40MA-MAX | 28480 | 5082-4371 |
| U802 | 1826-0138 | 8 | 1 | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
| U803 | 1LB3-0003 | 8 | 1 | IC HPIL 28 PIN | 28480 | 1LB3-0003 |
| U804 | 1820-3428 | 3 | 1 | IC MASKED 8048 | 28480 | 1820-3428 |
| U805 | 1820-1412 | 1 | 1 | IC DCDR CMOS BIN 2-TO-4-LINE DUAL 2-INP | 04713 | MC14556BCP |
| U806 | 1820-2537 | 3 | 3 | IC DRVR CMOS LINE DRVR OCTL | 27014 | MM74C244N |
| U807 | 1820-2537 | 3 | | IC DRVR CMOS LINE DRVR OCTL | 27014 | MM74C244N |
| U808 | 1820-2537 | 3 | | IC DRVR CMOS LINE DRVR OCTL | 27014 | MM74C244N |
| U809 | 1820-2216 | 5 | 1 | IC FF CMOS D-TYPE POS-EDGE-TRIG OCTL | 27014 | MM74C374N |
| U810 | 1820-1578 | 0 | 2 | IC SHF-RGTR CMOS D-TYPE PRL-IN PRL-OUT | 3L585 | CD4076BE |
| U811 | 1820-1578 | 0 | | IC SHF-RGTR CMOS D-TYPE PRL-IN PRL-OUT | 3L585 | CD4076BE |
| U812 | 1820-1416 | 5 | 3 | IC SCHMITT-TRIG TTL LS INV HEX 1-INP | 01295 | SN74LS14N |
| U813 | 1820-1416 | 5 | | IC SCHMITT-TRIG TTL LS INV HEX 1-INP | 01295 | SN74LS14N |
| U814 | 1820-1416 | 5 | | IC SCHMITT-TRIG TTL LS INV HEX 1-INP | 01295 | SN74LS14N |
| U815 | 1820-1746 | 4 | 1 | IC BFR CMOS INV HEX | 04713 | MC14049UBCP |
| U816 | 1820-1747 | 5 | 1 | IC GATE CMOS NAND QUAD 2-INP | 04713 | MC14011BCP |
| U817 | 1820-1745 | 3 | 1 | IC GATE CMOS NOR QUAD 2-INP | 04713 | MC14001BCP |
| U818 | 1858-0044 | 2 | 3 | XSTR-ARY | 28480 | 1858-0044 |
| U819 | 1858-0044 | 2 | | XSTR-ARY | 28480 | 1858-0044 |
| U820 | 1858-0044 | 2 | | XSTR-ARY | 28480 | 1858-0044 |
| W803 | 1251-0689 | 5 | 1 | CONNECTOR 2-PIN F POST TYPE | 28480 | 1251-0689 |
| W804 | 1251-3483 | 3 | 2 | CONNECTOR 4-PIN F POST TYPE | 28480 | 1251-3483 |
| W805 | 1251-3483 | 3 | | CONNECTOR 4-PIN F POST TYPE | 28480 | 1251-3483 |
| Y801 | 0410-1332 | 4 | 1 | CRYSTAL-6.003 MHZ | 28480 | 0410-1332 |

See introduction to this section for ordering information
*Indicates factory selected value

## Table 1-6-7. 12 Vdc Power Adapter Option (214) Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A3 | 03421-66515 | 1 | 1 | 12 VDC POWER ADAPTER OPTION BOARD (ERC 2607) | 28480 | 03421-66515 |
| C801 | 0180-0228 | 6 | 1 | CAPACITOR-FXD 22UF+-10% 15VDC TA | 56289 | 150D226X9015B2 |
| C802 | 0160-0155 | 6 | 1 | CAPACITOR-FXD 3300PF +-10% 200VDC POLYE | 28480 | 0160-0155 |
| C803 | 0160-4571 | 8 | 6 | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| C804 | 0180-1779 | 4 | 1 | CAPACITOR-FXD 18UF+-10% 35VDC TA | 56289 | 150D186X9035B2 |
| C805 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| C806 | 0180-0374 | 3 | 3 | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| C807 | 0160-0157 | 8 | 4 | CAPACITOR-FXD 4700PF +-10% 200VDC POLYE | 28480 | 0160-0157 |
| C808 | 0160-0157 | 8 | | CAPACITOR-FXD 4700PF +-10% 200VDC POLYE | 28480 | 0160-0157 |
| C809 | 0160-0157 | 8 | | CAPACITOR-FXD 4700PF +-10% 200VDC POLYE | 28480 | 0160-0157 |
| C810 | 0160-0157 | 8 | | CAPACITOR-FXD 4700PF +-10% 200VDC POLYE | 28480 | 0160-0157 |
| C811 | 0180-0291 | 3 | 1 | CAPACITOR-FXD 1UF+-10% 35VDC TA | 56289 | 150D105X9035A2 |
| C812 | 0180-0374 | 3 | | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| C813 | 0160-4571 | 8 | 2 | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| C814 | 0160-4822 | 2 | | CAPACITOR-FXD 1000PF +-5% 100VDC CER | 28480 | 0160-4822 |
| C819 | 0180-0374 | 3 | | CAPACITOR-FXD 10UF+-10% 20VDC TA | 56289 | 150D106X9020B2 |
| C820 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| C821 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0610-4571 |
| C822 | 0180-0309 | 4 | 2 | CAPACITOR-FXD 4.7UF +-20% 100VDC TA | 0420J | 150D475X0010A2 |
| C823 | 0180-0309 | 4 | | CAPACITOR-FXD 4.7UF +-20% 100VDC TA | 0420J | 150D475X0010A2 |
| CR801 | 1901-0782 | 8 | 2 | DIODE-SCHOTTKY 1N5821 30V 3A | 04713 | 1N5821 |
| CR802 | 1902-1383 | 9 | 1 | DIODE-ZENER 15.5V | 28480 | 1902-1383 |
| CR803 | 1884-0311 | 1 | 1 | SCR-S4060F 10A | 28480 | 1884-0311 |
| CR804 | 1901-0828 | 3 | 2 | DIODE-PWR RECT 50V 2.5A | 12969 | UES1101 |
| CR805 | 1901-0828 | 3 | | DIODE-PWR RECT 50V 2.5A | 12969 | UES1101 |
| CR806 | 1902-0958 | 2 | 1 | DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075% | 28480 | 1902-0958 |
| CR807 | 1910-0016 | 0 | 1 | DIODE-GE 60V 60MA 1US DO-7 | 28480 | 1910-0016 |
| CR808 | 1901-0050 | 3 | 4 | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR809 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR810 | 1901-0782 | 8 | | DIODE-SCHOTTKY 1N5821 30V 3A | 04713 | 1N5821 |
| CR812 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR814 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| F801 | 2110-0083 | 6 | 1 | FUSE 2.5A 250V NTD 1.25X .25 UL | 28480 | 2110-0083 |
| FC801 | 2110-0565 | 9 | 1 | FUSEHOLDER CAP 12A MAX FOR UL | 28480 | 2110-0565 |
| FX801 | 2110-0642 | 3 | 1 | FUSEHOLDER-EXTR POST 6.3A 250V BAY CAP | 28480 | 2110-0642 |
| J801 | 1251-0600 | 0 | 8 | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| J802 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| J803 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| J804 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| J805 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| J806 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| J807 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| J808 | 1251-0600 | 0 | | CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ | 28480 | 1251-0600 |
| JM801 | 7175-0057 | 5 | 5 | RESISTOR-ZERO OHMS SOLID TINNED COPPER | 28480 | 7175-0057 |
| JM802 | 7175-0057 | 5 | | RESISTOR-ZERO OHMS SOLID TINNED COPPER | 28480 | 7175-0057 |
| JM803 | 7175-0057 | 5 | | RESISTOR-ZERO OHMS SOLID TINNED COPPER | 28480 | 7175-0057 |
| JM804 | 7175-0057 | 5 | | RESISTOR-ZERO OHMS SOLID TINNED COPPER | 28480 | 7175-0057 |
| JM805 | 7175-0057 | 5 | | RESISTOR-ZERO OHMS SOLID TINNED COPPER | 28480 | 7175-0057 |
| L801 | 9140-0779 | 7 | 1 | INDUCTOR-FIXED 520UH @ 10KHZ, 0ADC | 28480 | 9140-0779 |
| L802 | 03421-67101 | 3 | 1 | IND-COMMON MODE | 28480 | 03421-67101 |
| MP1 | 03421-00202 | 5 | 1 | PNL-REAR 12VCD | 28480 | 03421-00202 |
| MP2 | 03421-00606 | 3 | 1 | SHLD-LEXAN HPIB | 28480 | 03421-00606 |
| MP3 | 03421-01203 | 8 | 1 | BRACKET-CONN | 28480 | 03421-01203 |
| MP4 | 03421-62101 | 3 | 1 | CONN-ASSSY HPIL | 28480 | 03421-62101 |
| MP5 | 03421-64105 | 1 | 1 | CVR ASSY-12VDC | 28480 | 03421-64105 |
| MP6 | 03421-04104 | 4 | 1 | CVR-12VDC | 28480 | 03421-04104 |
| MP7 | 03421-64107 | 3 | 1 | PLATE-MTG HPIB | 28480 | 03421-64107 |
| MP8 | 03421-61603 | 8 | 1 | CBL-ASSY CHARGER | 28480 | 03421-61603 |
| MP9 | 0515-0406 | 3 | 1 | SCREW-MACH M3 X 0.5 8MM-LG PAN-HD | 00000 | ORDER BY DESCRIPTION |
| MP10 | 0515-0416 | 5 | 1 | SCREW-MACH M4 X 0.7 16MM-LG PAN-HD | 00000 | ORDER BY DESCRIPTION |
| MP11 | 3050-0006 | 6 | 1 | WASHER-SHLDR NO. 10 .2-IN-ID .5-IN-OD | 28480 | 3050-0006 |
| MP12 | 0515-0054 | 7 | 1 | SCREW-MACH M3 X 0.5 10MM-LG PAN-HD | 28480 | 0515-0054 |
| MP13 | 0535-0004 | 9 | 1 | NUT-HEX DBL-CHAM M3 X 0.5 2.4MM-THK | 00000 | ORDER BY DESCRIPTION |
| MP14 | 2190-0005 | 0 | 1 | WASHER-LK EXT T NO. 4 .116-IN-ID | 28480 | 2190-0005 |
| MP15 | 3050-0716 | 5 | 1 | WASHER-FL MTLC NO. 5 .128-IN-ID | 28480 | 3050-0716 |
| MP16 | 1390-0626 | 4 | 1 | SCREW-CAPTIVE M3.0 X 10 | 28480 | 1390-0626 |
| MP17 | 1600-1172 | 4 | 1 | STPG-SS PIL CLIP | 28480 | 1600-1172 |
| MP18 | 0624-0023 | 1 | 1 | SCREW-TPG 4-40 .25-IN-LG PAN-HD-PHL | 00000 | ORDER BY DESCRIPTION |
| MP19 | 1251-0011 | 7 | 1 | CONNECTOR 4-PIN F JONES TYPE | 28480 | 1251-0011 |
| MP20 | 03421-61604 | 9 | 1 | 12VDC SOURCE CABLE | 28480 | 03421-61604 |

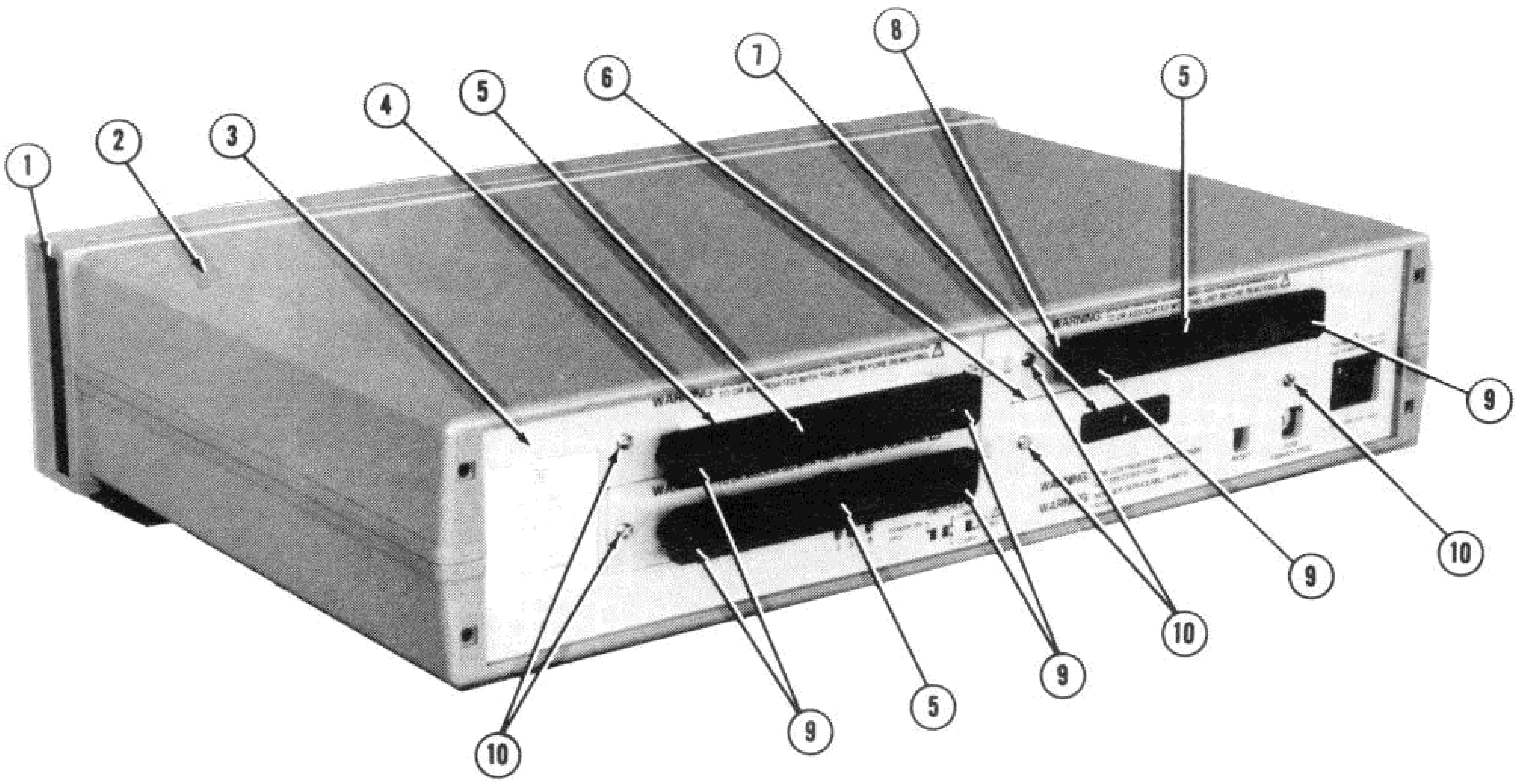
See introduction to this section for ordering information
*Indicates factory selected value

# Table 1-6-7. 12 Vdc Power Adapter Option (214) Replaceable Parts (Cont'd)

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| MP21 | 0340-1067 | 3 | 1 | INS-HT SHLD | 28480 | 0340-1067 |
| Q801 | 1854-0585 | 8 | 2 | TRANSISTOR NPN SI PD=12.5W FT=50MHZ | 04713 | MJE182 |
| Q802 | 1854-0585 | 8 | | TRANSISTOR NPN SI PD=12.5W FT=50MHZ | 04713 | MJE182 |
| Q803 | 1853-0051 | 1 | 1 | TRANSISTOR PNP 2N4037 SI TO-5 PD=1W | 3L585 | 2N4037 |
| R804 | 0757-0442 | 9 | 4 | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1002-F |
| R805 | 0757-0283 | 6 | 1 | RESISTOR 2K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-2001-F |
| R806 | 0757-0442 | 9 | | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1002-F |
| R807 | 0757-0346 | 2 | 1 | RESISTOR 10 1% .125W F TC=0+-100 | 34546 | C4-1/8-TO-10R0-F |
| R808 | 0757-0802 | 5 | 1 | RESISTOR 162 1% .5W F TC=0+-100 | 28480 | 0757-0802 |
| R809 | 0683-1325 | 2 | 1 | RESISTOR 1.3K 5% .25W FC TC=-400/+700 | 01121 | CB1325 |
| R810 | 0757-0198 | 2 | 2 | RESISTOR 100 1% .5W F TC=0+-100 | 28480 | 0757-0198 |
| R811 | 0757-0198 | 2 | | RESISTOR 100 1% .5W F TC=0+-100 | 28480 | 0757-0198 |
| R812 | 0757-0437 | 2 | 2 | RESISTOR 4.75K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-4751-F |
| R813 | 0757-0410 | 1 | 1 | RESISTOR 301 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-301R-F |
| R814 | 0698-3382 | 6 | 1 | RESISTOR 5.49K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5491-F |
| R815 | 0757-0438 | 3 | 3 | RESISTOR 5.11K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5111-F |
| R816 | 0757-0457 | 6 | 1 | RESISTOR 47.5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-4752-F |
| R817 | 0757-0449 | 9 | 3 | RESISTOR 20K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-2002-F |
| R818 | 0811-3056 | 3 | 2 | RESISTOR .24 5% .5W PW TC=0+-300 | 75042 | BW20-1/2-24/100-J |
| R819 | 0811-3056 | 3 | | RESISTOR .24 5% .5W PW TC=0+-300 | 75042 | BW20-1/2-24/100-J |
| R820 | 0698-4380 | 6 | 2 | RESISTOR 45.3 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-45R3-F |
| R821 | 0698-4380 | 6 | | RESISTOR 45.3 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-45R3-F |
| R822 | 0757-0437 | 2 | | RESISTOR 4.75K 1% .125W F TC=0+-100 | 34546 | C4-1/8-TO-4751-F |
| R823 | 0757-0401 | 0 | 2 | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-101-F |
| R824 | 0698-3158 | 4 | 1 | RESISTOR 23.7K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-2372-F |
| R825 | 0683-1025 | 9 | 2 | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| R826 | 0683-1025 | 9 | | RESISTOR 1K 5% .25W FC TC=-400/+600 | 01121 | CB1025 |
| R829 | 0757-0438 | 3 | | RESISTOR 5.11K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5111-F |
| R830 | 0698-4444 | 3 | 1 | RESISTOR 4.87K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-4871-F |
| R831 | 0757-0401 | 0 | | RESISTOR 100 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-101-F |
| R832 | 0683-1205 | 7 | 1 | RESISTOR 12 5% .25W FC TC=-400/+500 | 01121 | CB1205 |
| R833 | 0757-0438 | 3 | | RESISTOR 5.11K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5111-F |
| R834 | 0757-0449 | 9 | | RESISTOR 20K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-2002-F |
| R835 | 0698-4472 | 7 | 4 | RESISTOR 7.68K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-7681-F |
| R836 | 0757-0465 | 6 | 4 | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1003-F |
| R837 | 0698-8177 | 7 | 2 | RESISTOR 1.5 5% .25W | 28480 | 0698-8177 |
| R838 | 0698-4472 | 7 | | RESISTOR 7.68K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-7681-F |
| R839 | 0757-0465 | 6 | | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1003-F |
| R840 | 0698-6320 | 8 | 4 | RESISTOR 5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5001-F |
| R841 | 0698-6320 | 8 | | RESISTOR 5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5001-F |
| R842 | 0757-0449 | 9 | | RESISTOR 20K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-2002-F |
| R843 | 0698-4472 | 7 | | RESISTOR 7.68K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-7681-F |
| R844 | 0757-0465 | 6 | | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1003-F |
| R845 | 0698-8177 | 7 | | RESISTOR 1.5 5% .25W | 28480 | 0698-8177 |
| R846 | 0698-4472 | 7 | | RESISTOR 7.68K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-7681-F |
| R847 | 0757-0465 | 6 | | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1003-F |
| R848 | 0698-6320 | 8 | | RESISTOR 5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5001-F |
| R849 | 0798-6320 | 8 | | RESISTOR 5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5001-F |
| R850 | 0757-0442 | 9 | | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1002-F |
| R851 | 0757-0442 | 9 | | RESISTOR 10K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1002-F |
| T801 | 9100-4314 | 0 | 1 | XFMR-COUPLING | 28480 | 9100-4314 |
| U801 | 1826-0905 | 7 | 1 | IC V RGLTR-SWG 5/5.2V 16-DIP-P PKG | 28480 | 1826-0905 |
| U802 | 1826-0138 | 8 | 1 | IC COMPARATOR GP QUAD 14-DIP-P PKG | 01295 | LM339N |
| U803 | 1990-0444 | 6 | 1 | OPTO-ISOLATOR LED-PDIO/XSTR IF=25MA-MAX | 28480 | 1990-0444 |
| U804 | 1853-0409 | 3 | 2 | TRANSISTOR PNP SI DARL TO-220AB PD=60W | 28480 | 1853-0409 |
| U805 | 1854-0071 | 7 | 2 | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| U806 | 1853-0409 | 3 | | TRANSISTOR PNP SI DARL TO-220AB PD=60W | 28480 | 1853-0409 |
| U807 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| VR801 | 0837-0264 | 3 | 1 | MOV-1N6045A | 28480 | 0837-0264 |
| | 9170-0975 | 8 | 1 | CORE-TOROID AL=2750-NH/T | 28480 | 9170-0975 |

See introduction to this section for ordering information
*Indicates factory selected value

| 3421A Mechanical and Miscellaneous Parts | | | | |
|---|---|---|---|---|
| Index/Ref Number | HP Part Number | C D | Qty | Description |
| 1 | 5180-0223 | 6 | 2 | TRIM STRIP |
| 2Δ8 | 5040-5196 | 6 | 1 | TOP SHELL |
| 3 | 03421-00201 | 4 | 1 | PANEL-SILKSCREENED (REAR) |
| 4 | 4208-0416 | 8 | 3 | FOAM 90.1 X 9.99MM |
| 5 | 4040-2133 | 4 | 3 | STRAIN RELIEF |
| 6 | 03421-64101 | 7 | 1 | HP-IL COVER ASSEMBLY |
| 7 | 5061-4306 | 2 | 1 | PANEL RECEPTACLE PANEL ASSY W/1.0 IN LG |
| 8 | 03421-04103 | 3 | 3 | COVER-ACCESS (SILKSCREENED) |
| 9 | 1390-0630 | 0 | 6 | SCREW-CAPTIVE M3.0 X 16 |
| 9 | 3050-0716 | 5 | 6 | WASHER-FL SCR-5 |
| 10 | 1390-0626 | 4 | 8 | SCREW-CAPTIVE M3.0 X 10 THD |
| 11 | 0515-0212 | 9 | 5 | SCREW-MACH M3.5 X 0.6MM-LG PAN-HD |
| 12 | 0380-1576 | 3 | 4 | STANDOFF-HEX 19.05MM-LG M3.0 X 0.5-THD |
| 13 | 8120-3766 | 5 | 1 | WIRE-LGD 4'' (BLK) |
| 14 | 03421-01201 | 6 | 1 | BRACKET-BATTERY |
| 15 | 03421-00601 | 8 | 1 | SHIELD (BOTTOM) |
| 16 | 03421-00602 | 9 | 1 | SHIELD (TOP) |
| 17 | 0510-1168 | 6 | 1 | RETAINER-PUSH ON CIRC EXT .375-IN-DIA |
| 18Δ11 | 0535-0004 | 9 | 2 | NUT HEX M3.0 X 0.5 |
| 19 | 2190-0584 | 0 | 2 | WASHER-LK HLCL 3.0MM 3.1-MM-ID |
| 20 | 03421-60201 | 0 | 1 | FRONT PANEL ASSEMBLY |
| 21 | 8120-3765 | 4 | 1 | WIRE-LGD 26'' (RED) |
| 22 | 4135-0416 | 3 | 1 | PUSHROD-PLASTIC |
| 23 | 5041-0980 | 8 | 1 | KEY CAP POWER |
| 24 | 0510-0609 | 8 | 4 | RETAINER-PUSH ON RND EXT .079-IN-DIA |
| 25 | 1990-0871 | 3 | 1 | LIQUID CRYSTAL DISPLAY |
| 26 | 1600-1185 | 9 | 2 | FASTENER-RACK MOUNT |
| 27 | 0624-0282 | 4 | 2 | SCREW-TPG 6-32 .312-IN-LG PAN-HD-POZI |
| 28 | 0515-0406 | 3 | 1 | SCREW-MACH M3 X 0.5 8MM-LG PAN-HD |
| 29 | 3050-0010 | 2 | 7 | WASHER-FL MTLC NO. 6 .147-IN-ID |
| 30 | 0515-0229 | 0 | 4 | SCREW-MACH M3.5 X 0.6 50MM LG PAN-HD |
| 31 | 0515-0211 | 8 | 4 | SCREW-MACH M3 X 0.5 6MM-LG PAN-HD |
| 32 | 0380-1577 | 4 | 4 | STANDOFF-HEX 23-MM-LG M3.0 X 0.5-THD (TOP) |
| 32 | 0380-1576 | 3 | 4 | STANDOFF-HEX 19-MM-LG M3.0 X 0.5-THD |
| 33 | 0515-0412 | 1 | 2 | SCREW-MACH M3 X 0.5 25MM-LG PAN-HD |
| 34 | 3050-0066 | 8 | 2 | WASHER-FL MTLC NO. 6 .147-IN-ID |
| 35 | 4040-2132 | 3 | 6 | SPACER .57-IN-DIA 2.143-IN-LG |
| 36Δ8 | 0515-1325 | 3 | 6 | SCREW-MACH 4 X .7MM |
| 37 | 5040-7222 | 3 | 2 | FOOT NON-SKID |
| 38 | 5040-7201 | 8 | 2 | FOOT (STANDARD) |
| 39Δ8 | 5040-5195 | 5 | 1 | BOTTOM SHELL |
| 40 | 1460-1345 | 4 | 1 | TILT STAND SST |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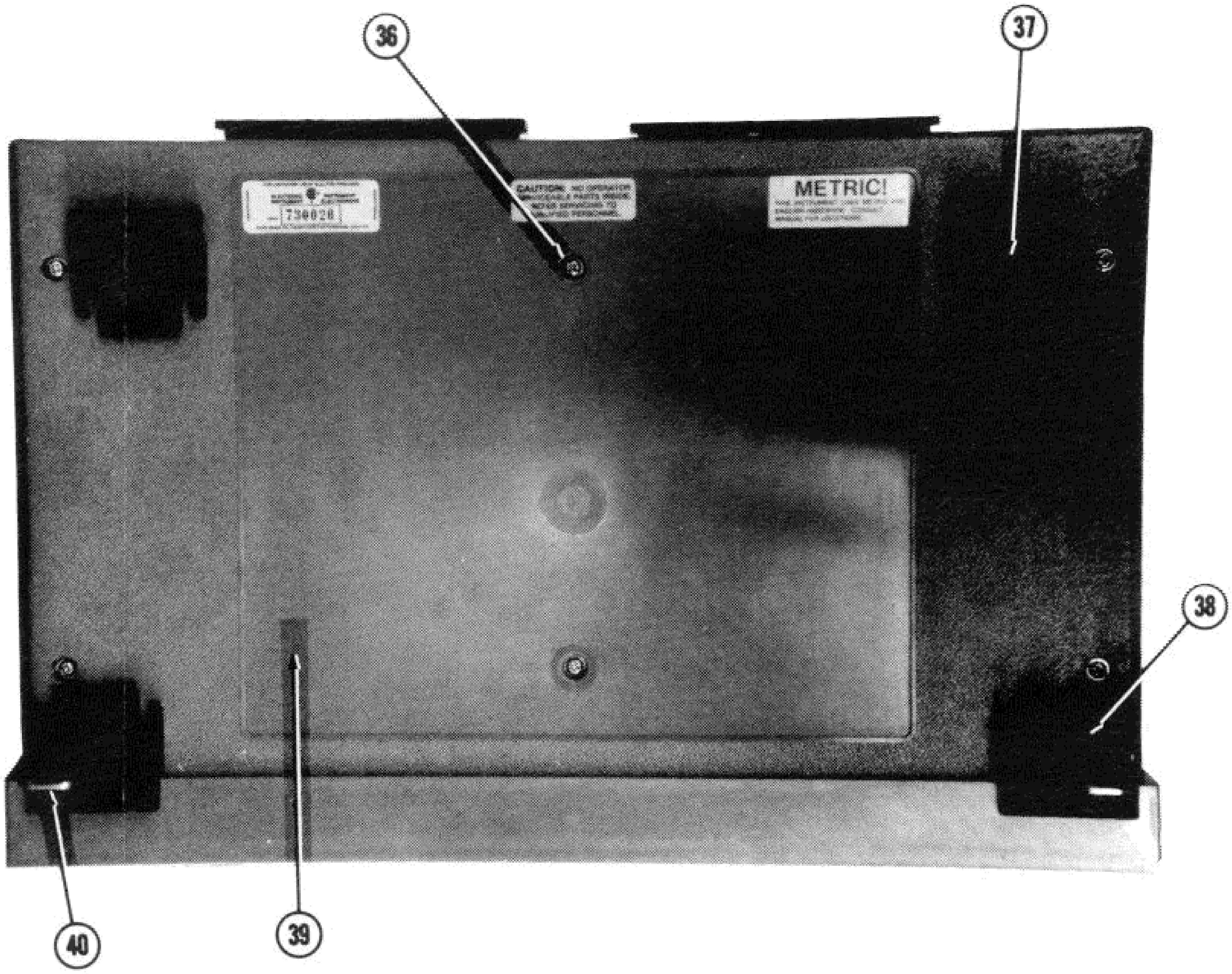
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CAUTION: NO OPERATOR SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL.
METRIC!
730028

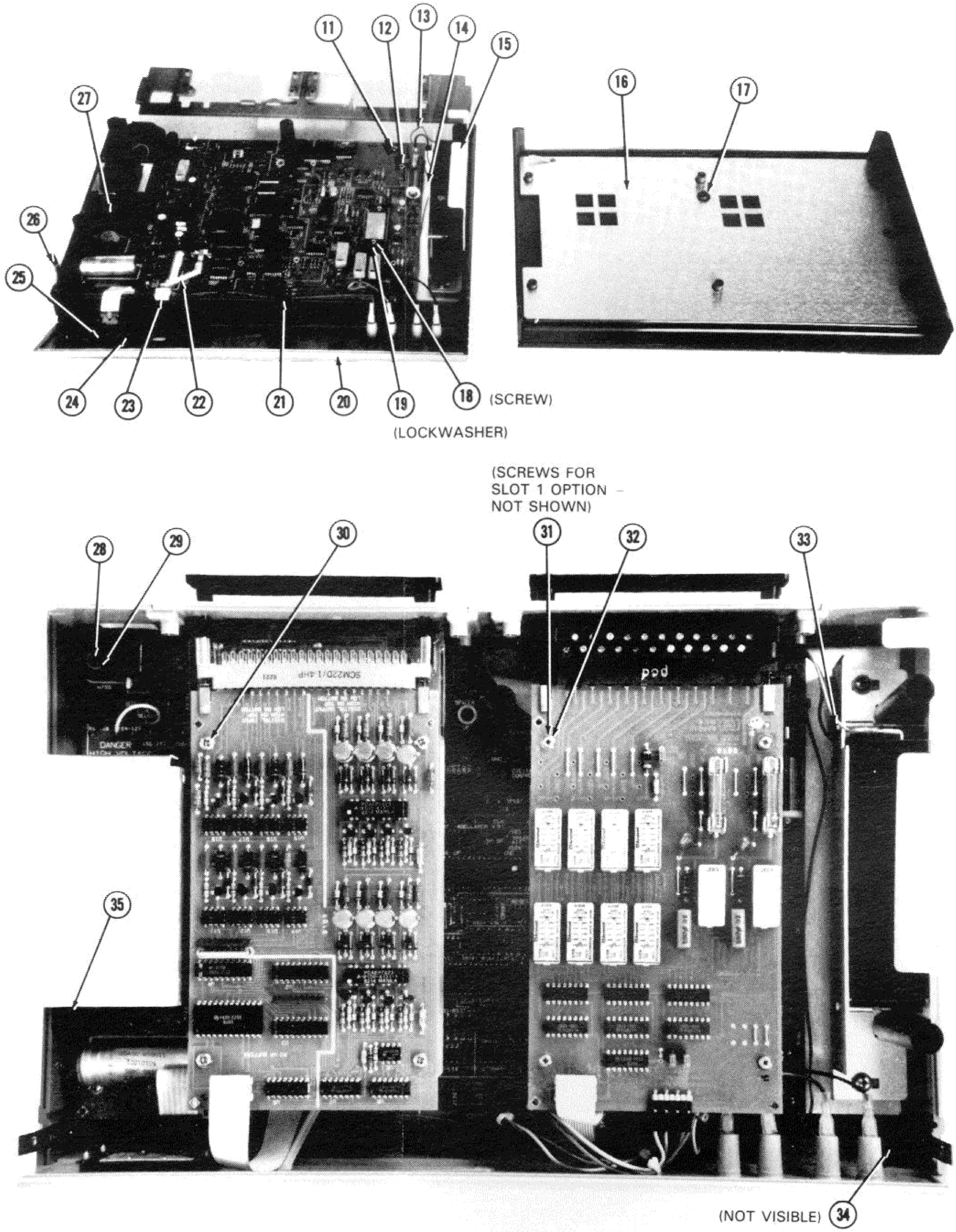


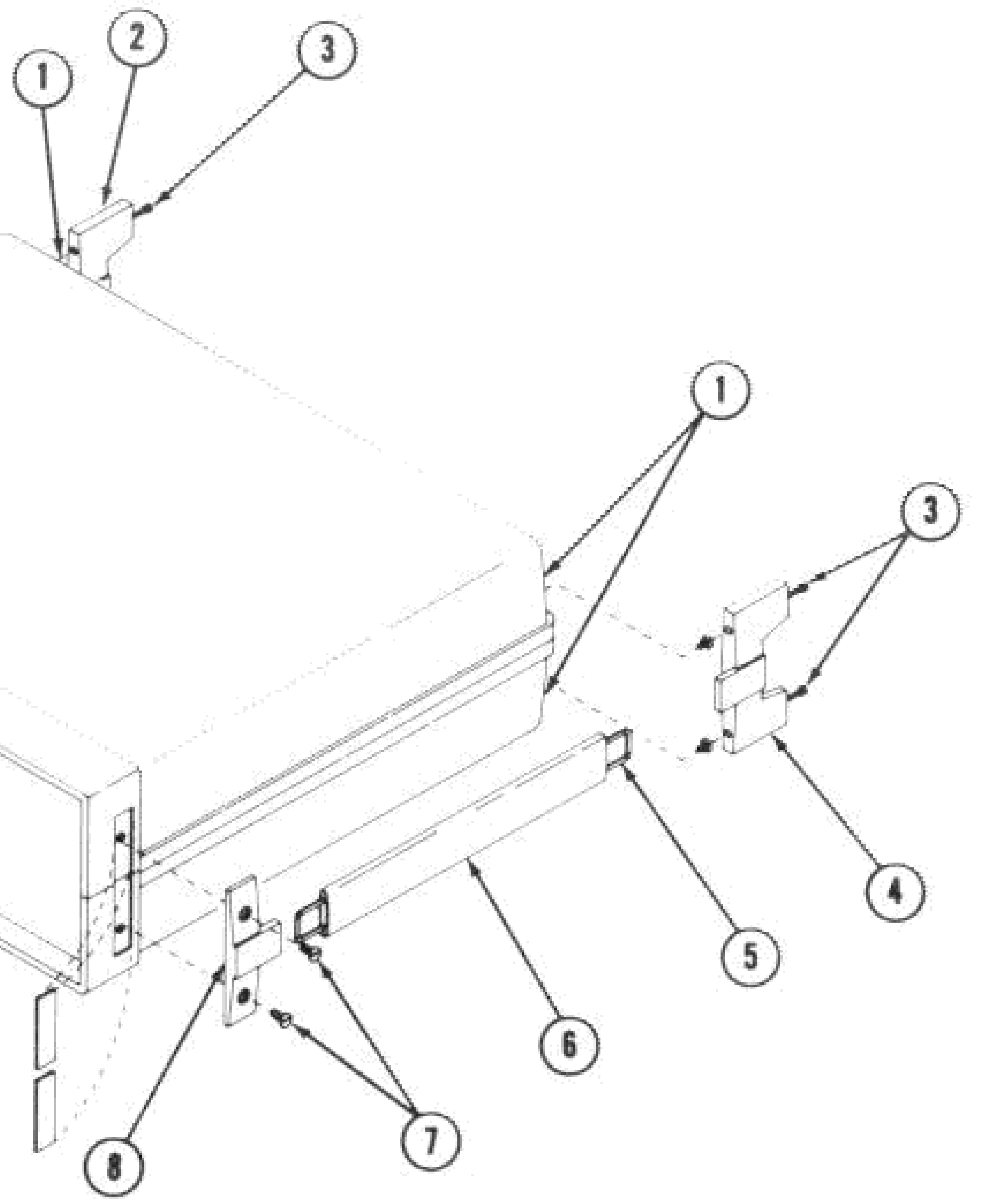

Figure 1-6-1. HP 3421A Miscellaneous and Mechanical Parts

| Side Handle Kit (Option 401 Mechanical and Miscellaneous Parts | | | | |
|---|---|---|---|---|
| Index/Ref Number | HP Part Number | C D | Qty | Description |
| | 5061-1171 | 3 | 1 | KIT-HNDL, S II IN |
| 1 | 0590-1428 | 9 | 4 | NUT-LOCKLINK |
| 2 | 4040-1991 | 0 | 1 | BUMPER-VERTICAL FT |
| 3 | 2360-0482 | 8 | 4 | SCREW-FILH 6-32 |
| 4 | 4040-1992 | 1 | 1 | HANDLE-MNT, REAR |
| 5 | 1460-1938 | 2 | 1 | WIRE FORM, HANDLE |
| 6 | 0890-1411 | 0 | 1 | EXTRUSION, HANDLE |
| 7 | 2510-0105 | 1 | 2 | SCREW-MACH 8-32 |
| 8 | 4040-1993 | 2 | 1 | HANDLE-MNT, FRONT |

| Front Handle Kit (Option 907) Mechanical and Miscellaneous Parts | | | | |
|---|---|---|---|---|
| Index/Ref Number | HP Part Number | C D | Qty | Description |
| | 5061-1170 | 2 | 1 | KIT-FRONT HNDL |
| 9 | 5061-9498 | 3 | 2 | HNDL-FRONT, SYS II |
| 10 | 2510-0106 | 2 | 4 | SCREW-MACH 8-32 |
| 11 | 5020-8895 | 6 | 2 | TRIM FRONT HNDL |

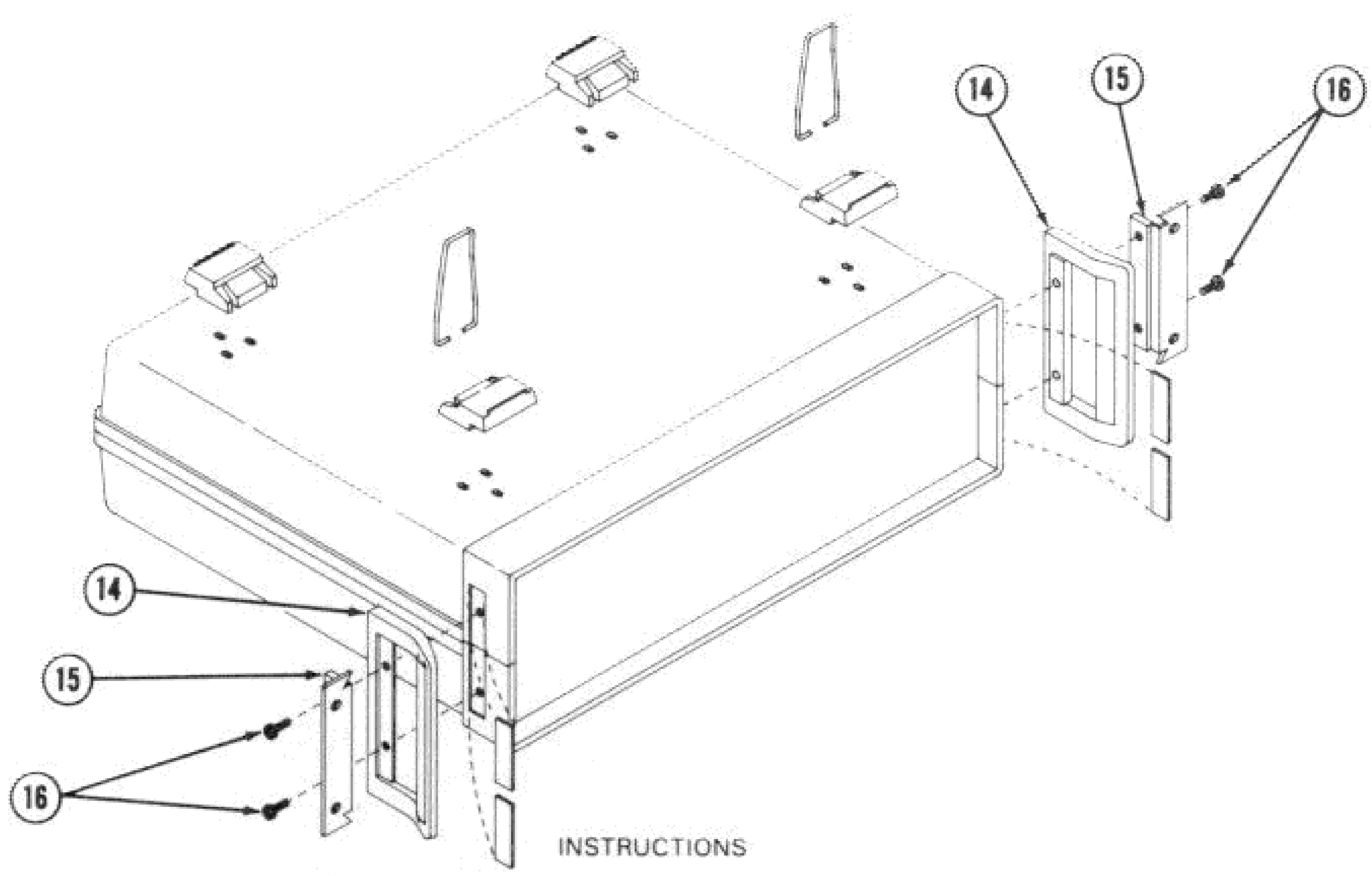
| Rack Mount Kit (Option 908) Mechanical and Miscellaneous Parts | | | | |
|---|---|---|---|---|
| Index/Ref Number | HP Part Number | C D | Qty | Description |
| | 5061-1168 | 8 | 1 | KIT-RKMT 3.51 IN |
| 12 | 5020-8934 | 4 | 2 | RACK MTG FL |
| 13 | 2510-0181 | 3 | 4 | SCREW-PH 8-32 .5LG |

| Rack Mount with Handle Kit (Option 909) Mechanical and Miscellaneous Parts | | | | |
|---|---|---|---|---|
| Index/Ref Number | HP Part Number | C D | Qty | Description |
| | 5061-1169 | 9 | 1 | KIT-RKMT/HNDLS |
| 14 | 5061-9498 | 3 | 2 | HNDL-FRONT, SYS II |
| 15 | 5020-8935 | 5 | 2 | RACK MTG FL |
| 16 | 2510-0111 | 9 | 4 | SCREW-MACH 8-32 |



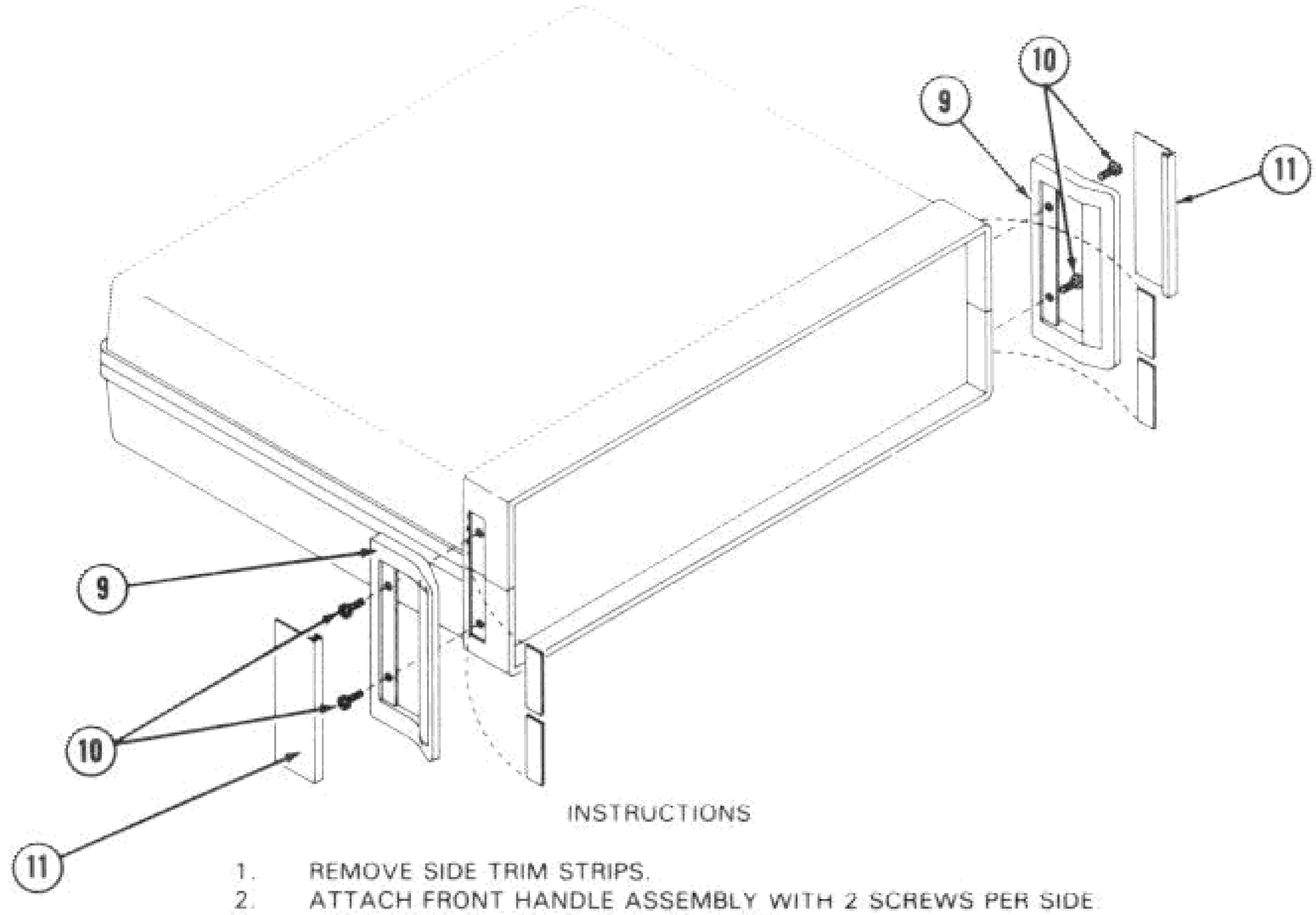

INSTRUCTIONS
(HANDLE TO BE INSTALLED ON RIGHT HAND SIDE ONLY)

1. REMOVE THE RIGHT HAND SIDE TRIM STRIPS.
2. INSTALL THE FOUR NUT-LOCK-LINKS INTO THE FOUR SQUARE HOLES ON THE REAR OF THE INSTRUMENT. GENTLY TAP THEM IN PLACE.
3. INSTALL THE VERTICAL BUMPER FOOT (4040-1991) ON THE REAR OF THE INSTRUMENT. THIS IS TO BE INSTALLED ON THE RIGHT SIDE AS YOU FACE THE REAR OF THE INSTRUMENT. USE 2 FILISTER HEAD SCREWS (2360-0482).
4. INSTALL WIREFORM (1460-1938) INTO (0890-1411) EXTRUSION HANDLE THEN HOOK ONE END OF THE WIRE FORM ON THE GROOVE IN THE REAR HANDLE MOUNTING (4040-1992). INSTALL USING 2 FILISTER HEAD SCREWS (2360-0482)
5. TAKE OTHER END OF HANDLE AND HOOK WIRE FORM OVER GROOVE IN FRONT HANDLE MOUNTING. USE 2 SCREWS (2510-0105) TO INSTALL FRONT HANDLE MOUNTING TO INSTRUMENT CASE SIDE.



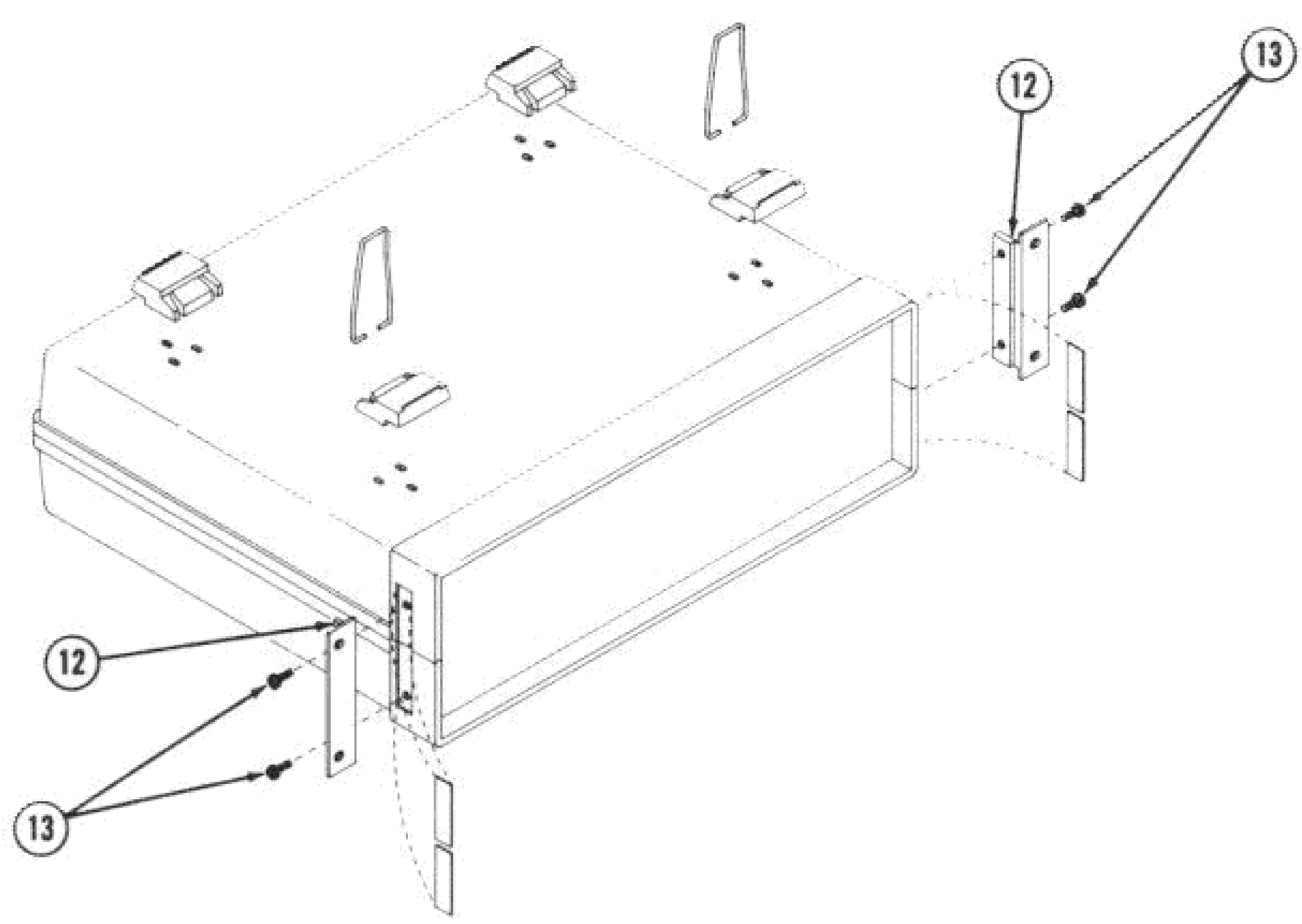

INSTRUCTIONS

1. REMOVE SIDE TRIM STRIPS.
2. ATTACH RACK MOUNT FLANGE AND FRONT HANDLE ASSEMBLY WITH 2 SCREWS PER SIDE.
3. REMOVE FEET AND TILT STANDS BEFORE RACK MOUNTING.




INSTRUCTIONS

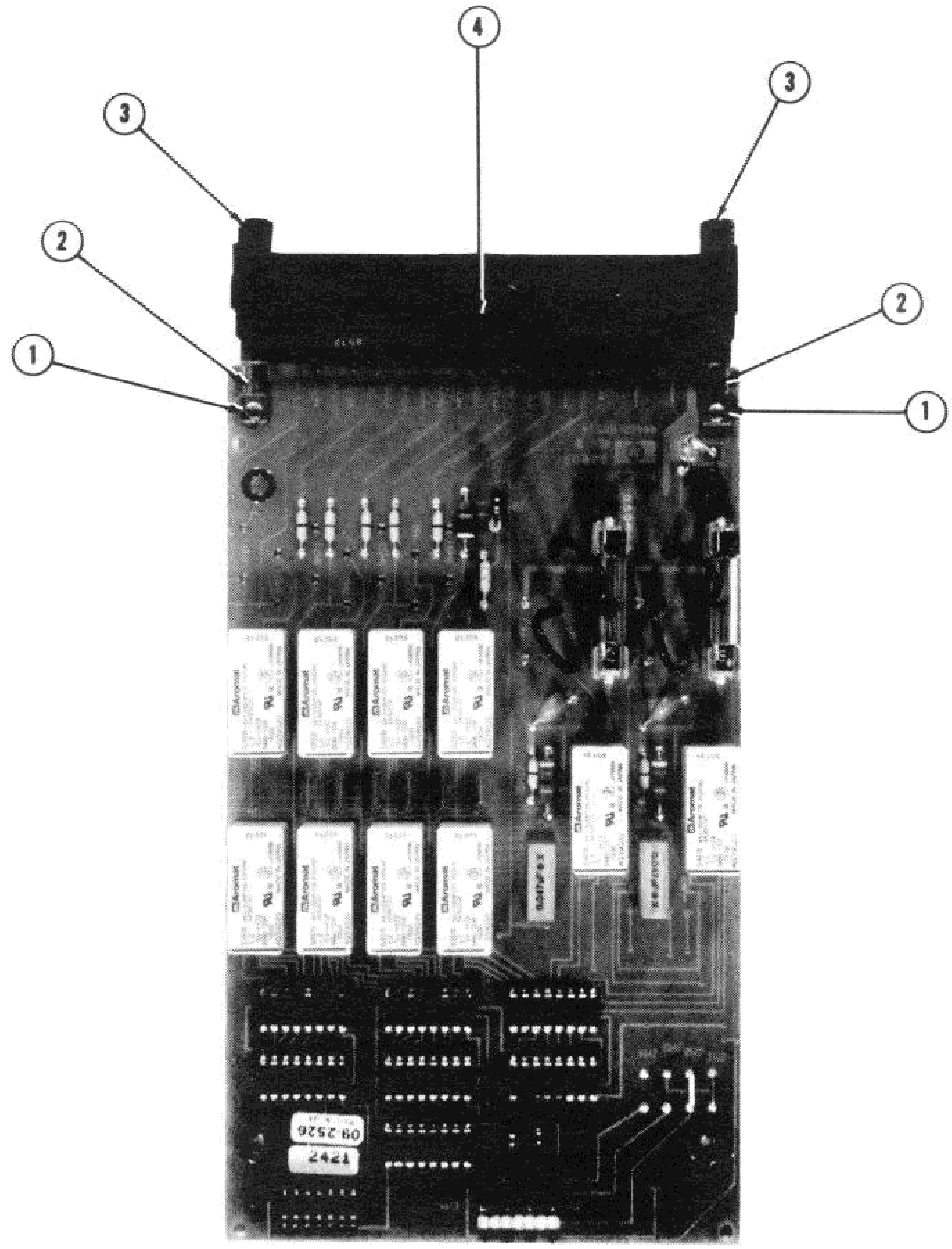
1. REMOVE SIDE TRIM STRIPS.
2. ATTACH FRONT HANDLE ASSEMBLY WITH 2 SCREWS PER SIDE.
3. PRESS FRONT HANDLE TRIM IN PLACE.




INSTRUCTIONS

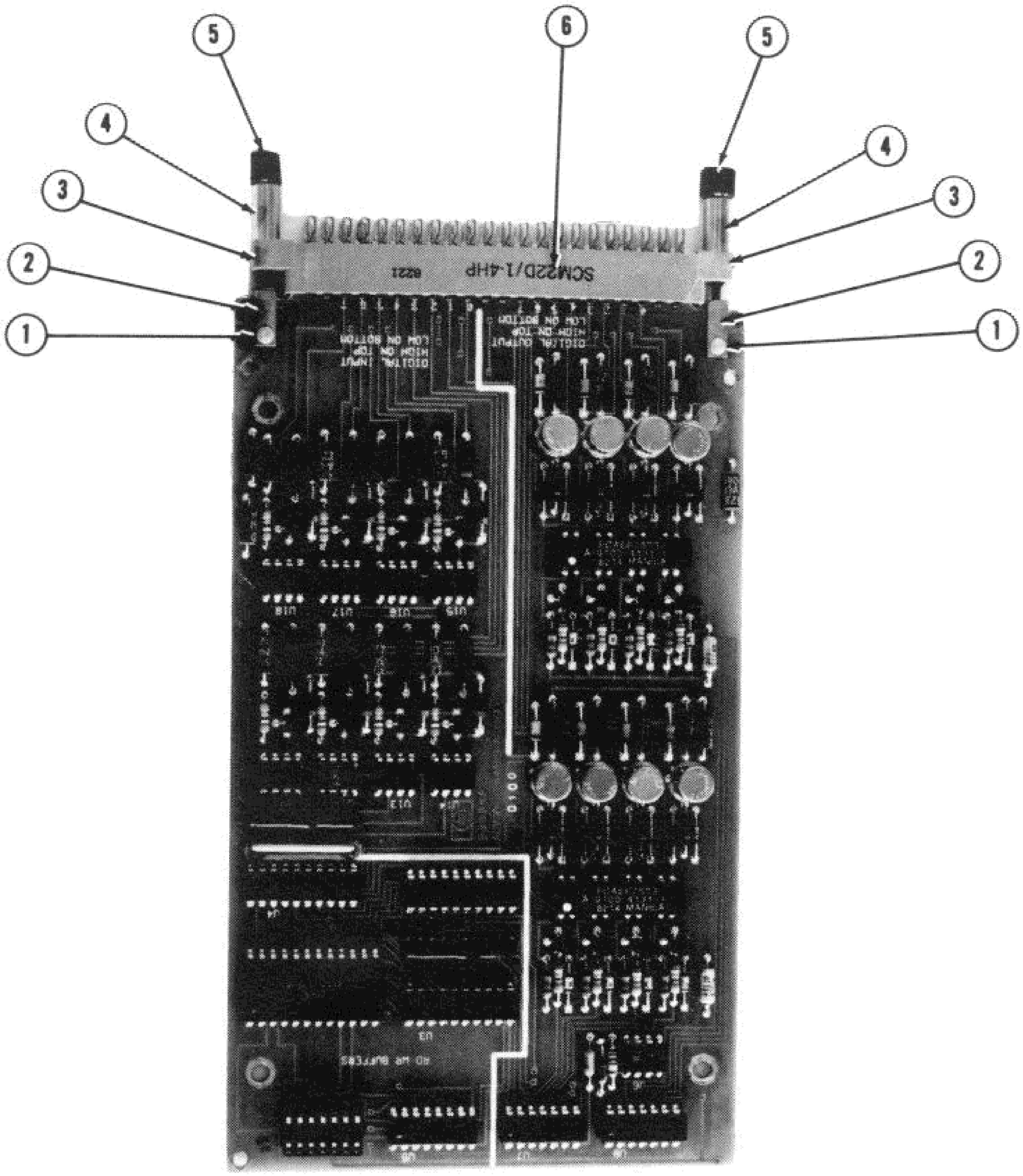
1. REMOVE SIDE TRIM STRIPS.
2. ATTACH RACK MOUNT FLANGE WITH 2 SCREWS PER SIDE.
3. REMOVE FEET AND TILT STANDS BEFORE RACK MOUNTING.

Figure 1-6-2. Handle and Rack Mounts Kits (Options 401, 907, 908, and 909)




| HP 44462A Multiplexer/Actuator Assembly Miscellaneous and Mechanical Parts | | | | |
|---|---|---|---|---|
| Index/Ref Number | HP Part Number | C D | Qty | Description |
| 1 | 1480-0617 | 4 | 2 | CLEVIS-M3.0 X 18.2 |
| 2 | 0510-0952 | 4 | 2 | RETAINER-RING E-R EXT .094-IN-DIA STL |
| 3 | 1390-0624 | 2 | 2 | SCREW-CAPTIVE M3.0 X 36 |
| 4* | 1251-7938 | 9 | 1 | CONNECTOR EDGE 2 X 11 |
| *Connector with instructions can be ordered under HP Number 44463 | | | | |

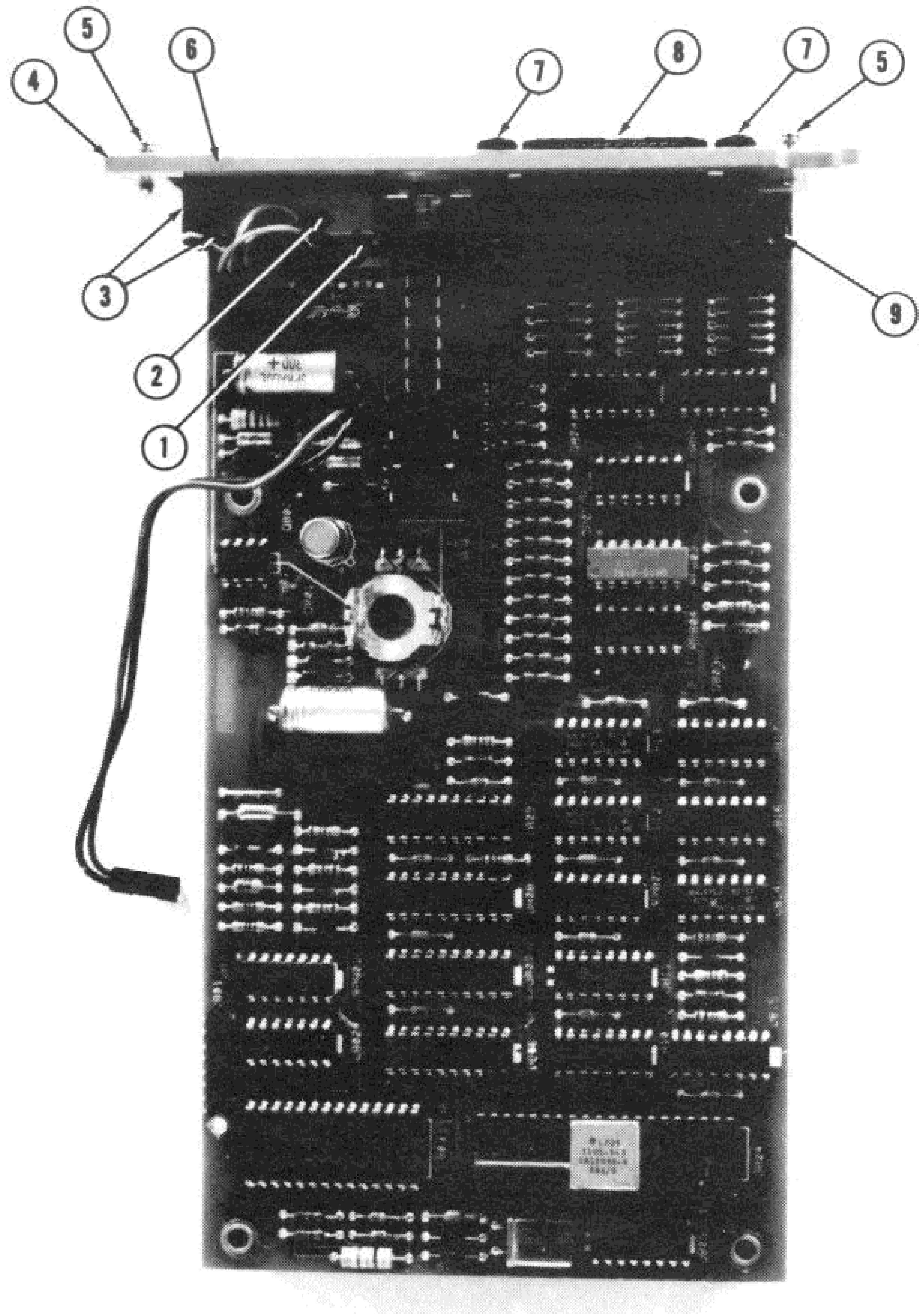
**Figure 1-6-3. HP 44462A Multiplexer/Actuator Assembly (Options 020, 021, 022) Mechanical and Miscellaneous Parts**




| HP 44465A Digital I/O Assembly Miscellaneous and Mechanical Parts | | | | |
|---|---|---|---|---|
| Index/Ref Number | HP Part Number | C D | Qty | Description |
| 1 | 1480-0617 | 4 | 2 | CLEVIS-M3.0 X 18.2 |
| 2 | 0510-0952 | 4 | 2 | RETAINER-RING E-R EXT .094-IN-DIA STL |
| 3 | 2190-0879 | 6 | 2 | WASHER-FL NM NO. 4 .128-IN-ID .245-IN-OD |
| 4 | 0380-0008 | 4 | 2 | SPACER-RND .5-IN-LG .18-IN-ID .25-IN-OD |
| 5 | 1390-0624 | 3 | 2 | SCREW-CAPTIVE M3.0 X 36 |
| 6* | 1251-0233 | 5 | 1 | CONNECTOR PC EDGE 22-CONT/ROW |

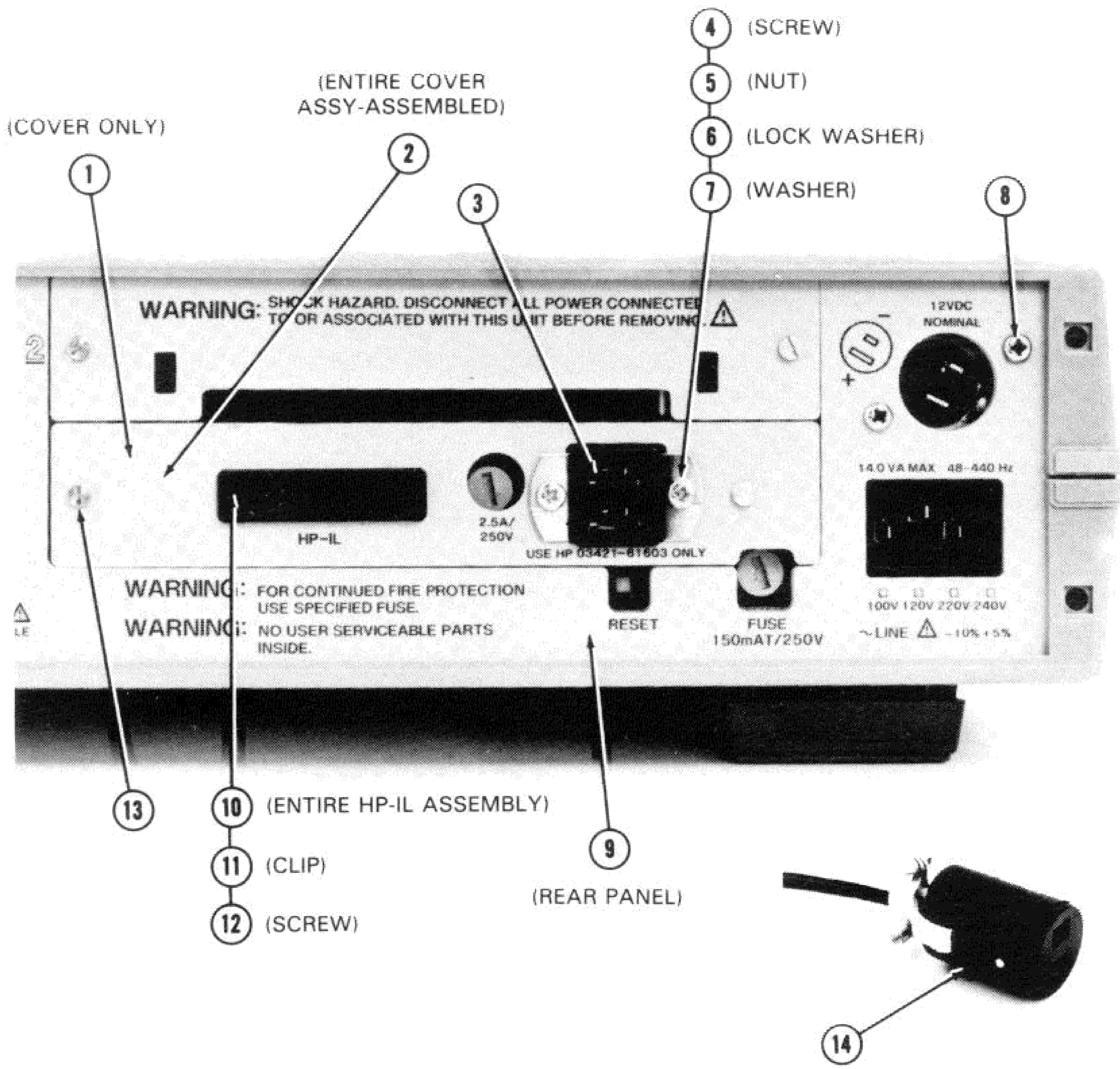
*Connector with hardware can be ordered using HP Number 44466-62101 Connector with hardware and instructions can be ordered under HP Number 44466A

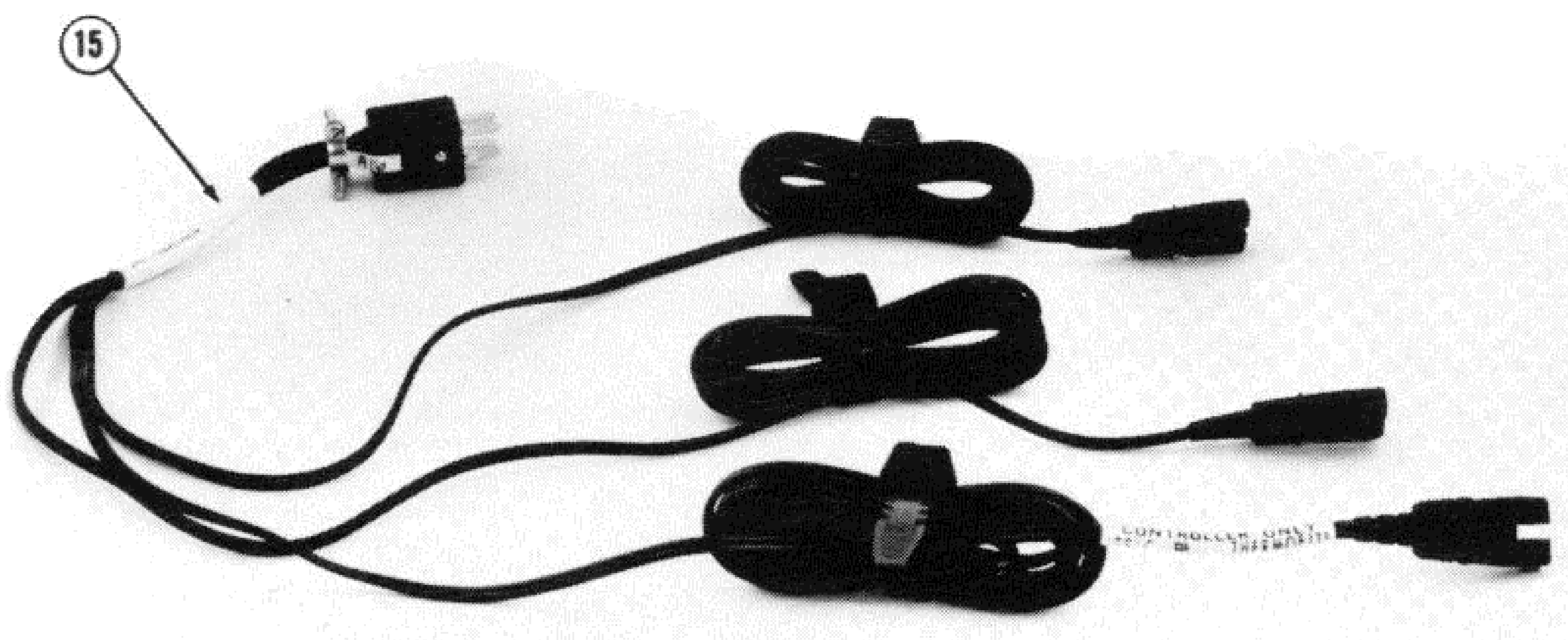
**Figure 1-6-4. HP 44465A Digital I/O Assembly (Option 050) Mechanical and Miscellaneous Parts**

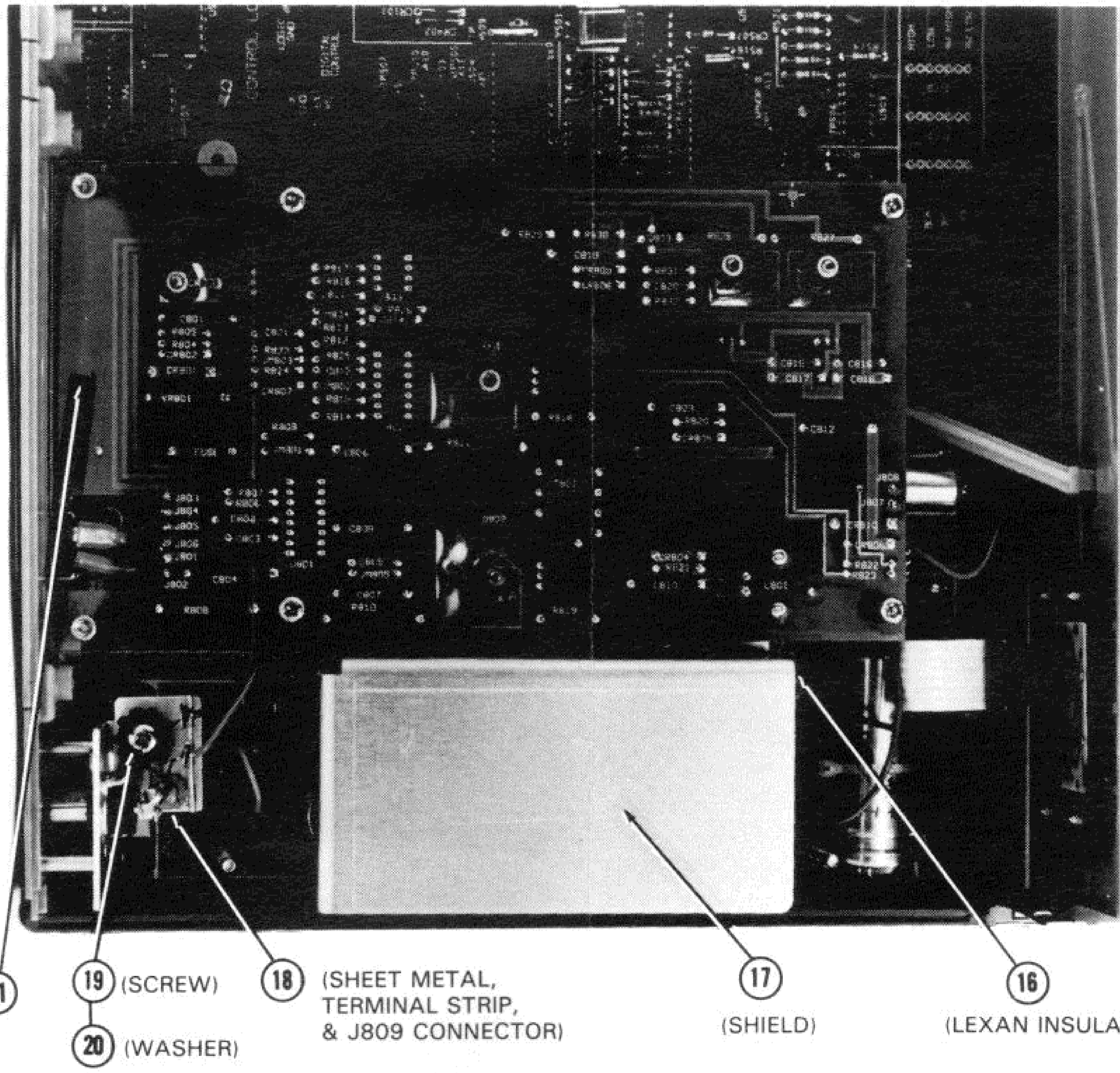



| HP 44461A HP-IB Option Assembly Miscellaneous and Mechanical Parts | | | | |
|---|---|---|---|---|
| **Index/Ref Number** | **HP Part Number** | **C D** | **Qty** | **Description** |
| 1 | 0624-0023 | 1 | 1 | SCREW-TPG 4-40 .25-IN-LG PAN-HD-PHL |
| 2 | 1600-1172 | 4 | 1 | STPG-SS PIL CLIP |
| 3 | 03421-62101 | 3 | 1 | CONN-ASSY HPIL |
| 4 | 03421-04101 | 1 | 1 | CVR-HP-IB, SSCRN'D |
| 5 | 1390-0626 | 4 | 2 | SCREW-CAPTIVE M3.0 X 10 |
| 6 | 03421-64102 | 8 | 1 | HP-IB-COVER ASSY |
| 7 | 0380-1188 | 3 | 2 | STANDOFF-HEX M/F .327-IN-LG 4-40-THD |
| 8 | 1251-5529 | 2 | 1 | CONNECTOR 24-PIN F AMP CHAMP |
| 9 | 0515-0211 | 8 | 1 | SCREW-MACH M3 X 0.5 6MM-LG PAN-HD |

**Figure 1-6-5. HP 44461A HP-IB Option Assembly (Option 201) Mechanical and Miscellaneous Parts**


(COVER ONLY)
1
(ENTIRE COVER ASSY-ASSEMBLED)
2
3
4 (SCREW)
5 (NUT)
6 (LOCK WASHER)
7 (WASHER)
8
WARNING: SHOCK HAZARD. DISCONNECT ALL POWER CONNECTED TO OR ASSOCIATED WITH THIS UNIT BEFORE REMOVING
12VDC NOMINAL
HP-IL
2.5A/250V
USE HP 03421-61603 ONLY
14.0 VA MAX 48-440 Hz
WARNING: FOR CONTINUED FIRE PROTECTION USE SPECIFIED FUSE.
WARNING: NO USER SERVICEABLE PARTS INSIDE.
RESET
FUSE 150mAT/250V
100V 120V 220V 240V
~LINE -10% +5%
13
10 (ENTIRE HP-IL ASSEMBLY)
11 (CLIP)
12 (SCREW)
9
(REAR PANEL)
14


15




**HP 3421A 12 Vdc Power Adapter Option Miscellaneous and Mechanical Parts**

| Index/Ref Number | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| 1 | 03421-04104 | 4 | 1 | COVER-12VCD |
| 2 | 03421-64105 | 1 | 1 | COVER ASSY-12VCD |
| 3 | 1251-0011 | 7 | 1 | CONNECTOR 4-PIN F JONES TYPE |
| 4 | 0515-0054 | 7 | 2 | SCREW-MACH M3 X 0.5 10MM-LG PAN-HD |
| 5 | 0535-0004 | 9 | 2 | NUT-HEX DBL-CHAN M3 X 0.5 2.4MM-THK |
| 6 | 2190-0005 | 0 | 2 | WASHER-LK EXT NO. 4 .116-IN-ID |
| 7 | 3050-0716 | 5 | 2 | WASHER-FL MTLC NO. 5 .128-IN-ID |
| 8 | 0515-0406 | 3 | 2 | SCREW-MACH M3 X 0.5 8MM-LG PAN-HD |
| 9 | 03421-00202 | 5 | 1 | PANEL-REAR 12VCD |
| 10 | 03421-62101 | 3 | 1 | CONNECTOR-ASSY HPIL |
| 11 | 1600-1172 | 4 | 1 | STPG-SS PIL CLIP |
| 12 | 0624-0023 | 7 | 1 | SCREW-TPG 4-40 .25-IN-LG PAN-HD-PHL |
| 13 | 1390-0626 | 4 | 2 | SCREW-CAPTIVE M3.0 X 10 |
| 14 | 03421-61604 | 9 | 1 | 12VDC SOURCE CABLE |
| 15 | 03421-61603 | 8 | 1 | CABLE-ASSY CHARGER |
| 16 | 0340-1067 | 3 | 1 | INS-HT SHLD |
| 17 | 03421-64107 | 3 | 1 | PLATE-MTG HPIB |
| 18 | 03421-01203 | 8 | 1 | BRACKET-CONN |
| 19 | 0515-0416 | 5 | 1 | SCREW-MACH M4 X 0.7 16MM-LG PAN-HD |
| 20 | 3050-0006 | 6 | 1 | WASHER-SHLDR NO. 10 .2-IN-ID .5-IN-OD |
| 21 | 03421-00606 | 3 | 1 | SHIELD-LEXAN HPIB |

Figure 1-6-6. HP 3421A 12 Vdc Power Adapter Option (Option 214) Mechanical and Miscellaneous Parts

# SECTION VII
# MANUAL CHANGES

## 1-7-1. INTRODUCTION

1-7-2. This section adapts Chapter I to HP 3421As with a serial number prefix, serial number, or ERC (Engineering Revision Code) number different than shown on the title page. The serial and ERC numbers are described in paragraphs 1-7-3 and 1-7-5, respectively.

### 1-7-3. Serial Numbers

1-7-4. The serial number is found on the HP 3421A's rear panel in the form of 0000A00000. The first four digits and the letter are the prefix. The last five digits are the suffix. The prefix is often the same for all identical units produced. It only changes when an instrument change occurs. Use the prefix number to help identify the instrument's electrical and mechanical configuration changes caused by engineering changes. For some changes, however, the prefix number may remain the same. The suffix is assigned sequentially. It is different for each instrument produced.

### 1-7-5. Engineering Revision Code (ERC)

1-7-6. The engineering revision code (ERC) is changed for any assembly change made. This includes a printed circuit board revision or a component value change. Added or deleted components, a component part number change, or a revised test and assembly procedure can also cause ERC changes. ERCs were implemented on the HP 3421A with the 03421-66511 motherboard introduction. The first ERC number was 2334. The number is on the ERC label and is the only one on the circuit board with four digits. Refer to Section I for more information on ERC numbers.

## 1-7-7. CHAPTER CHANGES

1-7-8. The changes listed in this section updates this chapter to your instrument. Most changes apply to the schematics and component locators in Section VIII (Service Group H), and to the parts list in Section VI. For minor component locator and schematic changes, use the information in this section to update Section VIII. For major changes, do not update Section VIII, but use the schematics and component locators in this section. For example, the control logic schematic and component locator for HP 3421A's with a 03421-66501 motherboard are in this section, instead of Section VIII.

1-7-9. Use Table 1-7-1 to locate the correct change number(s) for those intruments with a serial number prefix, serial number, or ERC number different than shown on the title page. Make the appropriate chapter changes under the change number(s). Make the highest number change first. For example, for changes 4 and 5, make change 5 first before making 4.

1-7-10. For any serial number prefix, serial number range, or ERC number not listed on the title page or in Table 1-7-1, refer to the *MANUAL CHANGES* supplement (if included) for updating information. Also make all indicated ERRATA changes to correct any errors in this chapter.

1-7-11. For any component values that are different on the schematic or parts list and are NOT listed in this section or a *MANUAL CHANGES* supplement, replace with the value presently on the schematic and parts list. Do the same with component part numbers.

Table 1-7-1. Chapter 1 Changes

| Serial Number or Serial Number Prefix | ERC Numbers | Make Changes |
|---|---|---|
| 2218A | None | 12,11,9,7,6,5,4,3,2,1 |
| 2236A | None | 12,11,9,7,6,5,4,3,2 |
| 2247A00181 thru 2247A00330 | None | 12,11,9,7,6,5,4 |
| 2247A00331 to Serial Prefix 3338A (but not including 2338A) | None | 12,11,9,7,6,5 |
| 2338A03035 and Below | None | 12,11,9,7,6 |
| 2338A03052 and Below | 2334 | 12,11,10,9,7 |
| 2338A03053 thru 2338A03265 | 2410 | 12,11,10,9,8 |
| 2338A04275 and Below | N/A | 12,11,10,9 |
| 2338A03052 thru 2338A03036 | 2334<br>2410<br>2417 | 12,11,10 |
| 2338A05625 and Below | 2505 and Below | 12,11 |
| 1228A06935 and Below | 2518 and Below | 12 |

## CHANGE 1

### Description

This change modifies the hardware used to secure the motherboard to the chassis, and the hardware used for options occupying slots 0 and 1. Instruments with serial prefix 2218A have four standoffs riveted to the motherboard to support the option occupying slot 0. Four spacers (P/N 0380-1877) separate the slot 0 and slot 1 options. The options are secured to the chassis by four screws (P/N 0515-0229). The four spacers and screws are also used to secure the motherboard to the chassis when there are no options in slots 0 and 1. The motherboard also requires one additional screw (P/N 0515-0406) to secure it to the chassis. The bottom shield for this serial prefix has screw holes that are sized to accomodate the four screws. This hole size was changed in later instruments. However, this shield is not available for replacement. If the motherboard is being replaced with one that does not have the standoffs riveted to it, the bottom shield must also be replaced with P/N 03421-00601.

### Figure 1-6-1. (Miscellaneous Parts) Changes

Do the changes in the table in Figure 1-6-1 as shown in Table 1-7-2.

Table 1-7-2. Make changes in the Table in Figure 1-6-1 (Change 1)

| Index/Ref Number | HP Part Number | CD | Qty | Description |
|---|---|---|---|---|
| Delete: | | | | |
| 12 | 0380-1576 | 3 | 4 | STANDOFF-HEX 19.05-MM-LG M3.0 X 0.5-THD |
| 31 | 0515-0211 | 8 | 4 | SCREW-MACH M3 X 0.5 6MM-LG PAN-HD |
| 32 | 0380-1577 | 4 | 4 | STANDOFF-HEX 23-MM-LG M3.0 X 0.5-THD |
| Change: | | | | |
| 28 | 0515-0406 | 8 | 1 | SCREW-MACH M3 X 0.5 8MM-LG PAN-HD |
| Add: | | | | |
| | 0380-1577 | 4 | 4 | STANDOFF-HEX 23-MM-LG M3 X 0.5-THD |
| | 0515-0229 | 8 | 4 | SCREW-MACH M3.5 X 0.6 50MM-LG PAN-HD |

## CHANGE 2

### Description

This changes the electrical configuration of the power transformer, deletes two test points, and deletes the HP-IB ground connector.

### Schematic 3 (Power Supply) Changes

Use the schematic in Figure 1-7-8 instead of Schematic 3 in Service Group H. Make the following changes in the figure.

Delete J702 (HP-IB Ground Connector), TP509, and TP510.

Change the electrical configuration of the power transformer as shown in Figure 1-7-1.

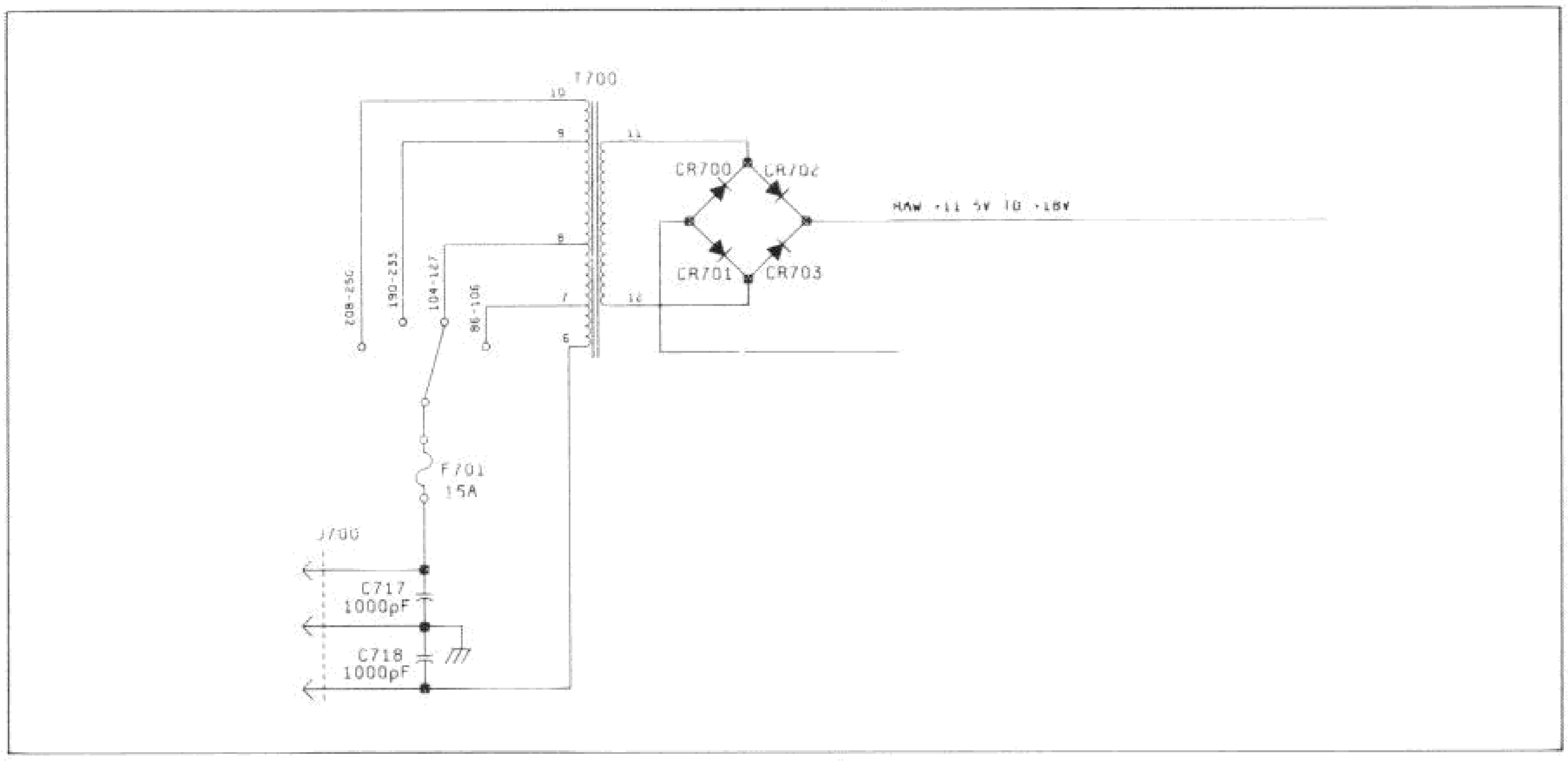



**Figure 1-7-1. Power Transformer Configuration for Serial Number Prefix 2236A and Below**

### Component Locator Changes

Use the component locator in Figure 1-7-4 instead of the one in Service Group H. Make the following changes in the figure.

Delete J702 (HP-IB Ground Connector), TP509, and TP510.

### Table 1-6-3. (Replaceable Parts) Changes

Do the changes in Table 1-6-3 as shown in Table 1-7-3.

**Table 1-7-3. Make Changes in Table 1-6-3 (Change 2)**

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Delete: A1J702 | 1251-7467 | 1 | 1 | CONNECTOR-SGL CONT QDISC-M .11-IN-BSC-SZ |
| Change: | 1251-0600 | 0 | 32 | (Under Miscellaneous) CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ |

## CHANGE 3

### Description

This change applies to the instrument's control logic and power supply circuitry. It consists of deleting C518 and C519 in the clock circuitry and changing the value of R583. Also, the value of R726 is changed in the power supply's electrostatic protection circuitry. The R583 and R726 resistor values presently in the HP 3421A improves the counter's input sensitivity and improves the electrosttic protection circuit's protection capability. If R583 or R726 is to be changed, use the values presently in Table 1-6-3.

### Schematic 2 (Control Logic) Changes

Use the schematic in Figure 1-7-5 instead of Schematic 2 in Service Group H. Make the following changes in the figure.

Delete C518 and C519

Add a connection between U508 pin 3 and U510 pin 4

Change R583 from 15k to 39k

### Schematic 3 (Power Supply) Changes

Use the schematic in Figure 1-7-8 instead of Schematic 3 in Service Group H. Make the following changes in the figure.

Change R726 from 470 to 10k

### Component Locator Changes

Use the component locator in Figure 1-7-4 instead of the locator in Service Group H. Make the following changes in the figure.

Delete C518 and C519

### Table 1-6-3 (Replaceable Parts) Changes

Do the changes in Table 1-6-3 as shown in Table 1-7-4.

**Table 1-7-4. Make Changes in Table 1-6-3 (Change 3)**

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Delete: | | | | |
| A1C518 | 0160-4801 | 7 | 1 | CAPACITOR-FXD 100PF ±5% 100VDC CER |
| A1C519 | 0160-3847 | 9 | 3 | CAPACITOR-FXD .01UF +100-0% 50VDC CER |
| Change: | | | | |
| A1R204 | 0683-4715 | 0 | 1 | RESISTOR 470 5% .25W FC TC=-400/+600 |
| A1R583 | 0683-3935 | 6 | | RESISTOR 39K 5% .25W FC TC=-400/+800 |
| A1R722 | 0757-0442 | 9 | 2 | RESISTOR 10K 1% .125W F TC=0±100 |
| A1R726 | 0757-0442 | 9 | | RESISTOR 10K 1% .125W F TC=0±100 |

## CHANGE 4

### Description

This change alters the value of R308 in the AC to DC Converter. The resistor presently in the circuit increases the current to U301 to prevent possible oscillations. If the resistor is to be replaced, use the value presently in Table 1-6-3.

### Schematic 1 (Input Circuitry) Changes

Do the following changes on Schematic 1 located in Service Group H.

Change R308 from 3M to 10M

### Table 1-6-3 (Replaceable Parts) Changes

Do the changes in Table 1-6-3 as shown in Table 1-7-5.

**Table 1-7-5. Make Changes in Table 1-6-3 (Change 4)**

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: A1R308 | 0699-0073 | 8 | 1 | RESISTOR 10M 1% .125W F TC=;-150 |

## CHANGE 5

### Description

Starting with serial number prefix 2338A, a motherboard revision occurred. The motherboard part number for that prefix is 03421-66511 and the ERC number is 2334. Before the change, the motherboard part number was 03421-66501. For the 03421-66501 motherboards, use the component locator in Figure 1-7-4 (in this section) in place of the one in Service Group H. Also use the schematic in Figure 1-7-5 in place of Schematic 2 in Service Group H.

### Schematic 1 (Input Circuitry) Changes

Do the following changes on Schematic 1 located in Service Group H.

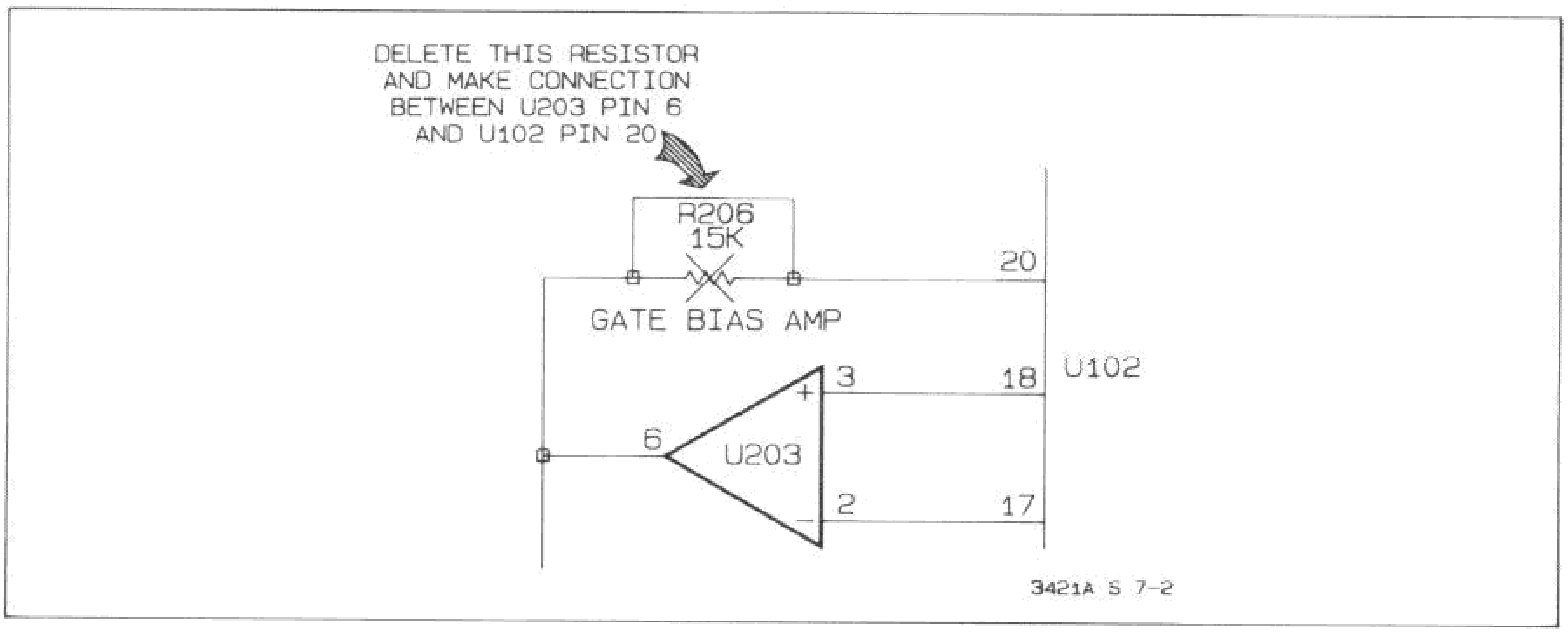



**Figure 1-7-2. Delete R206 from Schematic 1 (in Service Group H)**

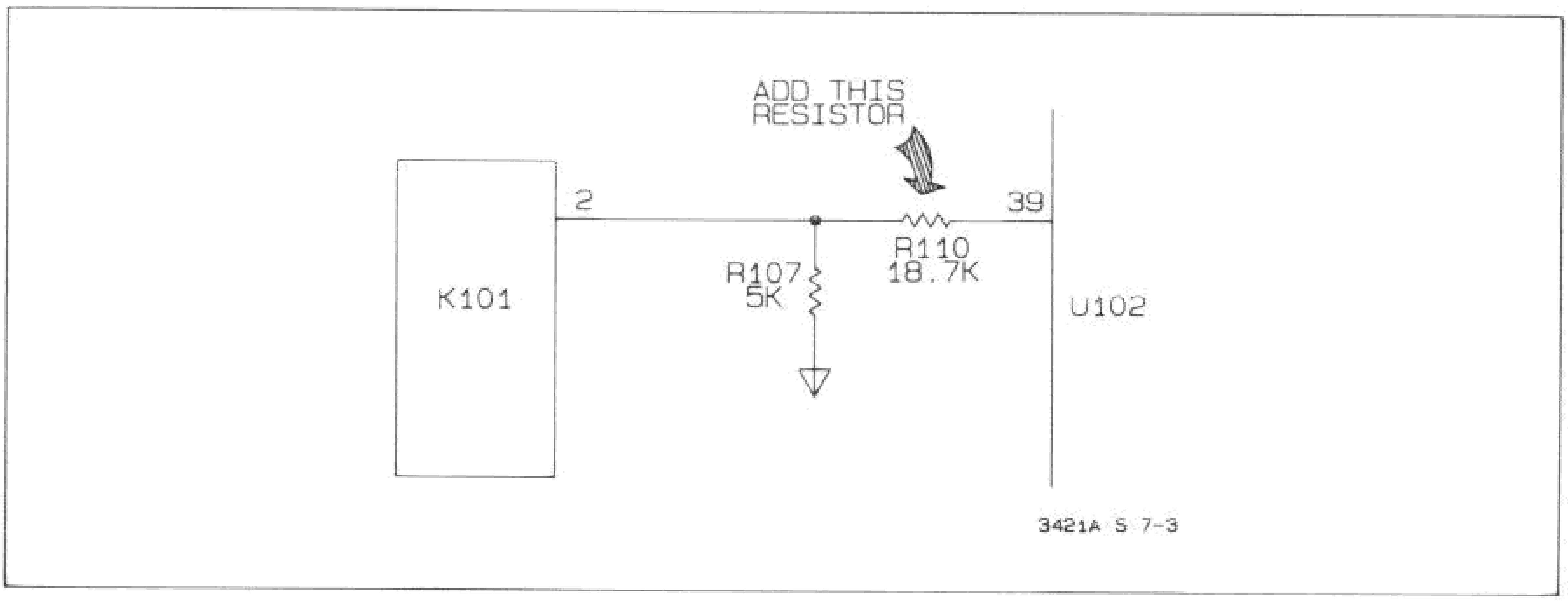



**Figure 1-7-3. Add R110 to Schematic 1 (in Service Group H)**

Delete R206 and make a connection between U203 pin 6 and U102 pin 20 as shown in Figure 1-7-2.

Add R110 to Schematic 1 as shown in Figure 1-7-3.

### Schematic 2 (Control Logic) Changes

Use the schematic in Figure 1-7-5 instead of Schematic 2 in Service Group H.

### Schematic 3 (Power Supply) Changes

Use the schematic in Figure 1-7-8 instead of Schematic 3 in Service Group H. Make the following changes in the figure.

Delete R732 and C721.

## Component Locator Changes

Use the component locator in Figure 1-7-4 instead of the locator in Service Group H.

## Table 1-6-3 (Replaceable Parts) Changes

Do the changes in Table 1-6-3 as shown in Table 1-7-6.

**Table 1-7-6. Make Changes in Table 1-6-3 (Change 5)**

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Delete: | | | | |
| A1C540 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 10VDC TA |
| A1C721 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 10VDC TA |
| A1CR540 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| A1CR541 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| A1CR542 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| A1CR543 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| A1CR544 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| A1CR545 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| A1R206 | 0683-1535 | 6 | 2 | RESISTOR 15K 5% .25W FC TC=−400/+800 |
| A1R540 | 0698-4483 | 0 | 3 | RESISTOR 18.7K 1% .125W F TC=0±100 |
| A1R541 | 0698-4483 | 0 | | RESISTOR 18.7K 1% .125W F TC=0±100 |
| A1R542 | 0698-4483 | 0 | | RESISTOR 18.7K 1% .125W F TC=0±100 |
| A1R732 | 0683-1005 | 5 | | RESISTOR 10 5% .25W FC TC=−400/+500 |
| Change: | | | | |
| A1CR300 | 1901-0050 | 3 | 10 | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| A1CR501 | 1902-0970 | 8 | 2 | DIODE-ZNR 33V 5% DO-D5 PD=+.097% |
| A1CR502 | 1902-0970 | 8 | | DIODE-ZNR 33V 5% DO-D5 PD=+.097% |
| A1R503 | 0683-1535 | 6 | 3 | RESISTOR 15K 5% .25W TC=−400/+800 |
| A1R504 | 0683-1835 | 6 | | RESISTOR 15K 5% .25W TC=−400/+800 |
| A1R505 | 0683-1045 | 3 | 5 | RESISTOR 100K 5% .25W TC=−400/+800 |
| A1R584 | 0683-5115 | 6 | 1 | RESISTOR 510 5% .25W FC=−400/+600 |
| A1T501 | 9140-0600 | 3 | 1 | TRANSFORMER-P/L DRIVER |
| Add: | | | | |
| A1C501 | 0160-4810 | 8 | 2 | CAPACITOR-FXD 330PF ±5% 100VDC CER |
| A1C502 | 0160-4810 | 8 | | CAPACITOR-FXD 330PF ±5% 100VDC CER |
| A1CR503 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2SN DO-35 |
| A1CR504 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2SN DO-35 |
| A1CR508 | 1902-0040 | 3 | 1 | DIODE-ZNR 14V 5% DO-35 PD=.4W TC=+.56% |
| A1Q531 | 1854-0215 | 1 | | TRANSISTOR NPN SI PD=350MW FT=300MHZ |
| A1R110 | 0698-4483 | 0 | 1 | RESISTOR 18.7K 1% .125W F TC=0±100 |
| A1R501 | 0698-3446 | 3 | 2 | RESISTOR 383 1% .125W F TC=0±100 |
| A1R502 | 0698-3446 | 3 | | RESISTOR 383 1% .125W F TC=0±100 |
| A1R515 | 0683-1055 | 5 | 1 | RESISTOR 1M 5% .25W FC TC=−800/+900 |
| A1R534 | 0683-1045 | 3 | | RESISTOR 100K 5% .25W FC TC=−400/+800 |
| A1R535 | 0683-5135 | 0 | | RESISTOR 51K 5% .25W FC TC=−400/+800 |
| A1T502 | 9100-4199 | 9 | 1 | TRANSFORMER-PULSE RECEIVER XFMR |

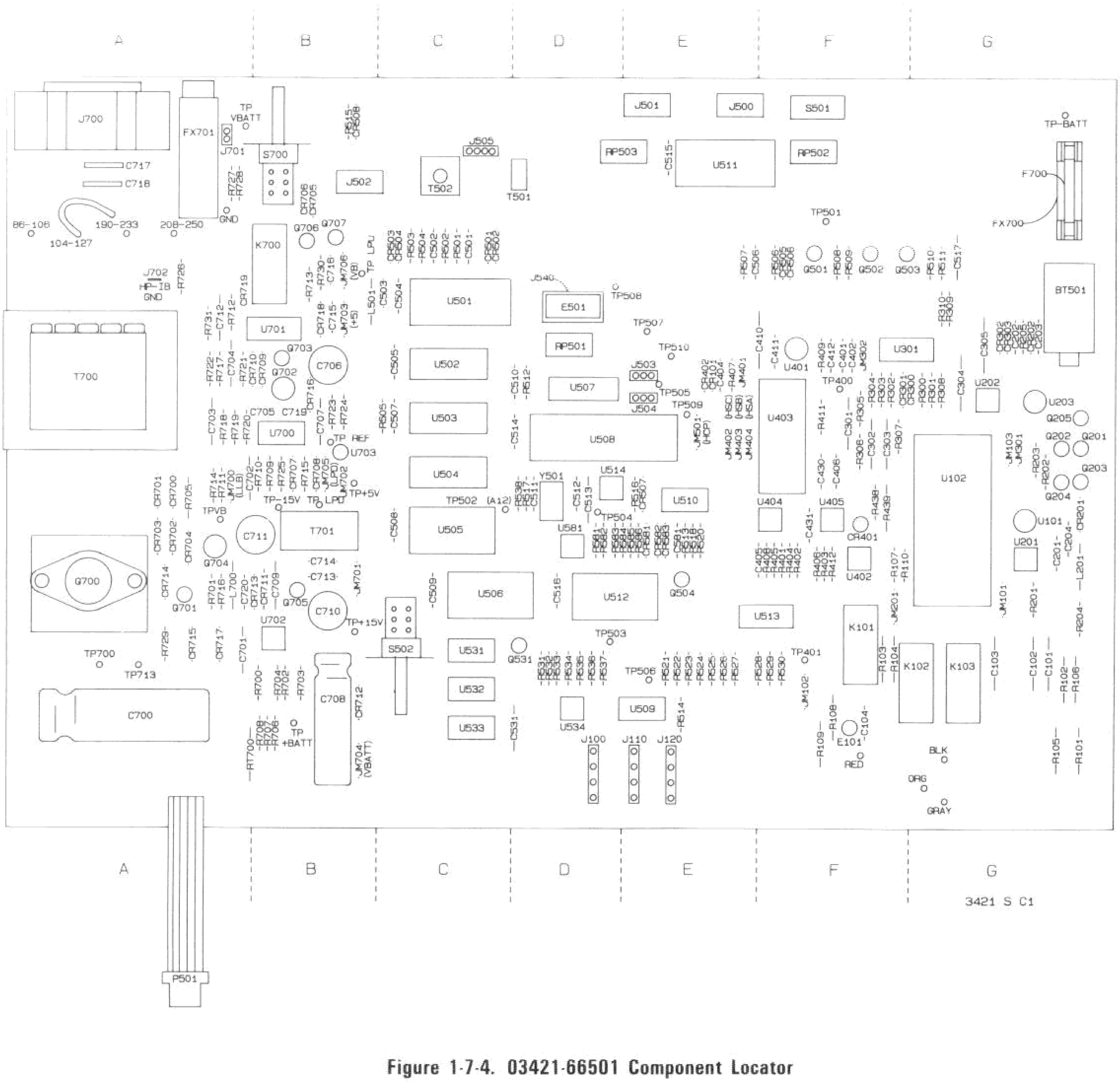


Figure 1-7-4. 03421-66501 Component Locator

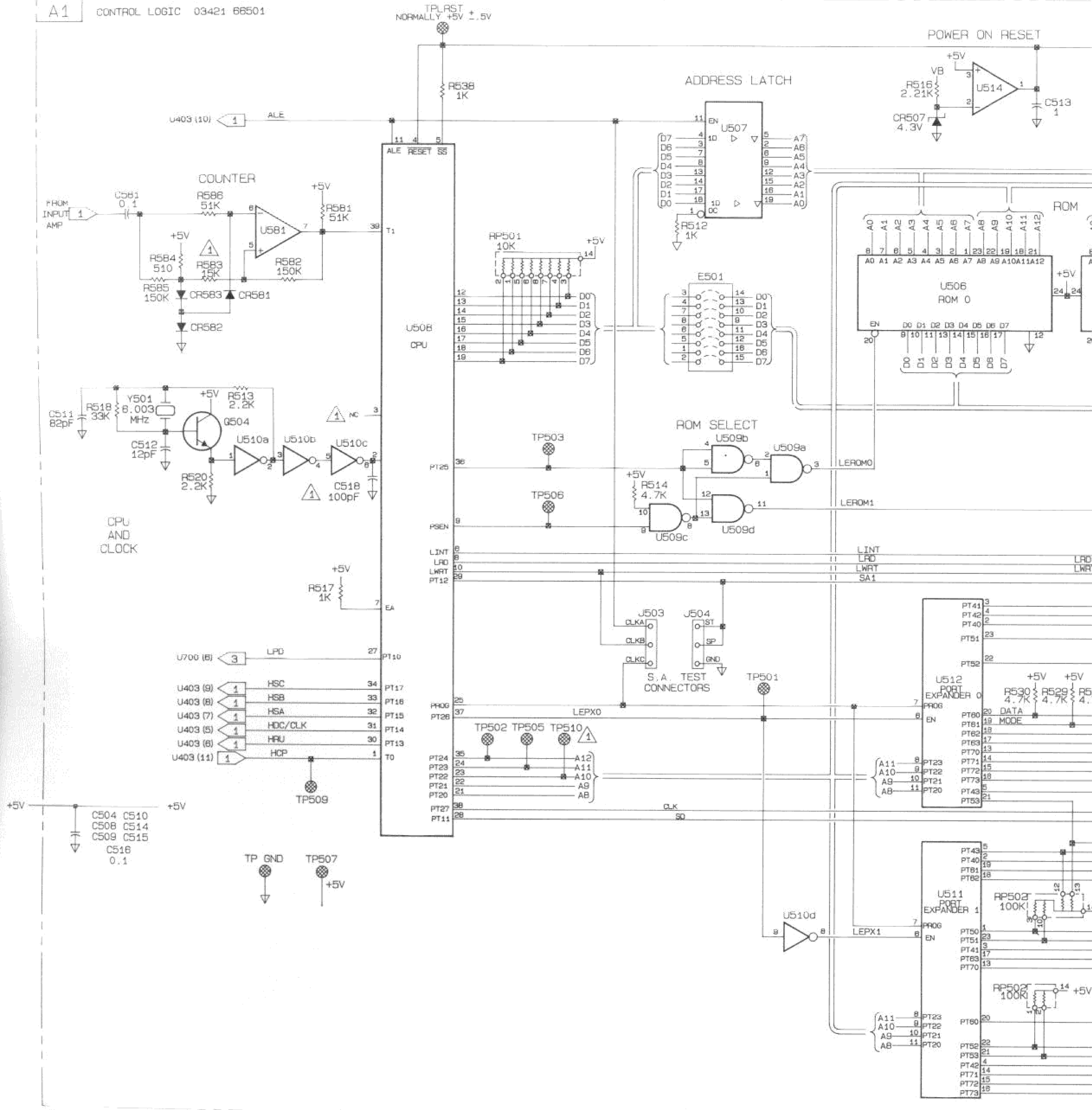
## IC Power Supply Configurations for Control Logic

| IC # | Type | -hp- P/N | RAW | +15V | −15V | VB | VBATT | +5V | GND |
|---|---|---|---|---|---|---|---|---|---|
| U501 | HP-IL | 1LB3-0003 | — | — | — | — | — | 1,2,21,22 | 10 |
| U502 | UPD5101 | 1818-1754 | — | — | — | — | — | 22 | 8,19 |
| U503 | UPD5101 | 1818-1754 | — | — | — | — | 22 | 22 | 8,19 |
| U504 | UPD5101 | 1818-1754 | — | — | — | — | 22 | 22 | 8,19 |
| U505 | 64k ROM | 1818-3079 | — | — | — | — | — | 24 | 12 |
| U506 | 64k ROM | 1818-3080 | — | — | — | — | — | 24 | 12 |
| U507 | 74LS373 | 1820-2102 | — | — | — | — | — | 20 | 10 |
| U508 | 8039 CPU | 1820-2718 | — | — | — | — | — | 40,26 | 20 |
| U509 | 74LS00 | 1820-1197 | — | — | — | — | — | 14 | 7 |
| U510 | 74LS04 | 1820-1199 | — | — | — | — | — | 14 | 7 |
| U511 | 8243 | 1820-2177 | — | — | — | — | — | 24 | 12 |
| U512 | 8243 | 1820-2177 | — | — | — | — | — | 24 | 12 |
| U513 | MC14050 | 1820-1146 | — | — | — | — | — | 1 | 8 |
| U514 | LM393 | 1826-0412 | — | 8 | — | — | — | — | 4 |
| U531 | MC14001 | 1820-1745 | — | — | — | 14 | — | — | 7 |
| U532 | MC14081 | 1820-1486 | — | — | — | 14 | — | — | 7 |
| U533 | MC14013 | 1820-0939 | — | — | — | 14 | — | — | 7 |
| U534 | LM393 | 1826-0412 | — | — | — | — | — | 8 | 4 |
| U581 | LM393 | 1826-0412 | — | — | — | — | — | 8 | 4 |

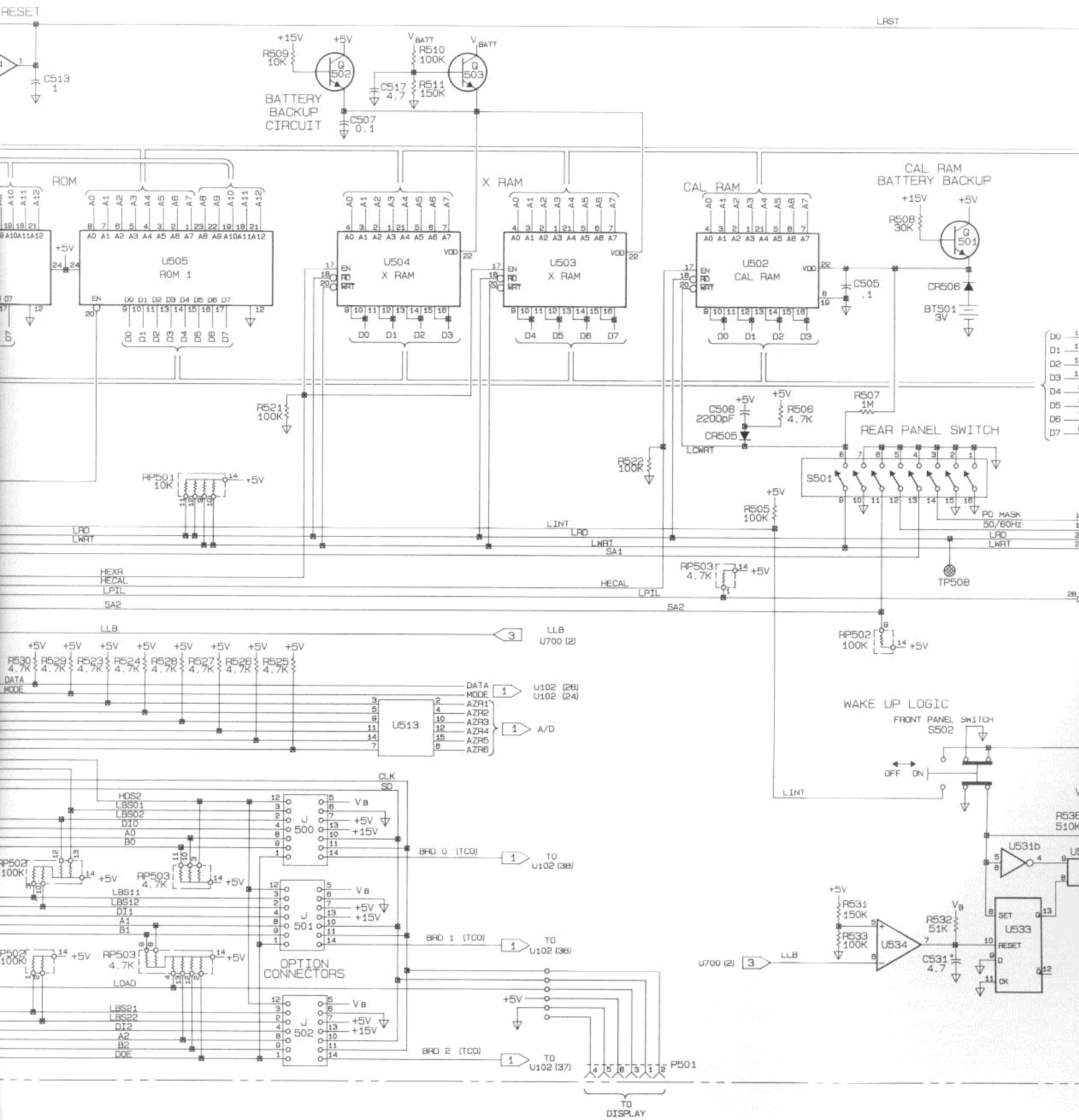
## Grid Locator For Control Logic Components

| Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column |
|---|---|---|---|---|---|---|---|
| BT501 | G | J501 | E | R520 | E | TP501 | F |
| C501 | C | J502 | B | R521 | E | TP502 | C |
| C502 | C | J503 | E | R522 | E | TP503 | D |
| C503 | C | J504 | E | R523 | E | TP504 | D |
| C504 | C | J505 | C | R524 | E | TP505 | E |
| C505 | C | J540 | D | R525 | E | TP506 | E |
| C506 | E | L501 | B | R526 | E | TP507 | E |
| C507 | C | P501 | A | R527 | E | TP508 | D |
| C508 | C | Q501 | F | R528 | E-F | TP509 | E |
| C509 | C | Q502 | F | R529 | F | TP510 | E |
| C510 | D | Q503 | F | R530 | F | U501 | C |
| C511 | D | Q504 | E | R531 | D | U502 | C |
| C512 | D | R501 | F | R532 | D | U503 | C |
| C513 | D | R502 | F | R533 | D | U504 | C |
| C514 | D | R503 | C | R536 | D | U505 | C |
| C515 | E | R504 | C | R537 | D | U506 | C |
| C516 | D | R505 | C | R538 | D | U507 | D |
| C517 | G | R506 | F | R581 | D | U508 | D |
| C531 | D | R507 | E | R582 | D | U509 | E |
| C581 | E | R508 | F | R583 | D | U510 | E |
| CR501 | C | R509 | F | R584 | D-E | U511 | E |
| CR502 | C | R510 | G | R585 | E | U512 | D-E |
| CR505 | F | R511 | G | R586 | E | U513 | E-F |
| CR506 | F | R512 | D | RP501 | D | U514 | D |
| CR507 | E | R513 | E | RP502 | F | U531 | C |
| CR508 | B | R514 | E | RP503 | D-E | U532 | C |
| CR581 | E | R515 | B | S501 | F | U533 | C |
| CR582 | E | R516 | E | S502 | C | U534 | D |
| CR583 | E | R517 | D | T501 | D | U581 | D |
| E501 | D | R518 | E | T502 | C | Y501 | E |
| J500 | E | | | | | | |

A1 CONTROL LOGIC 03421 66501




THIS INDICATES A CHANGE FROM THE ORIGINAL DESIGN


RESET
LRST
BATTERY
BACKUP
CIRCUIT
ROM
U505
ROM 1
X RAM
U504
X RAM
U503
X RAM
CAL RAM
U502
CAL RAM
CAL RAM
BATTERY BACKUP
REAR PANEL SWITCH
S501
WAKE UP LOGIC
FRONT PANEL SWITCH
S502
OFF ON
U513
U531b
U533
U534
OPTION
CONNECTORS
J 500
J 501
J 502
P501
TO
DISPLAY

Figure

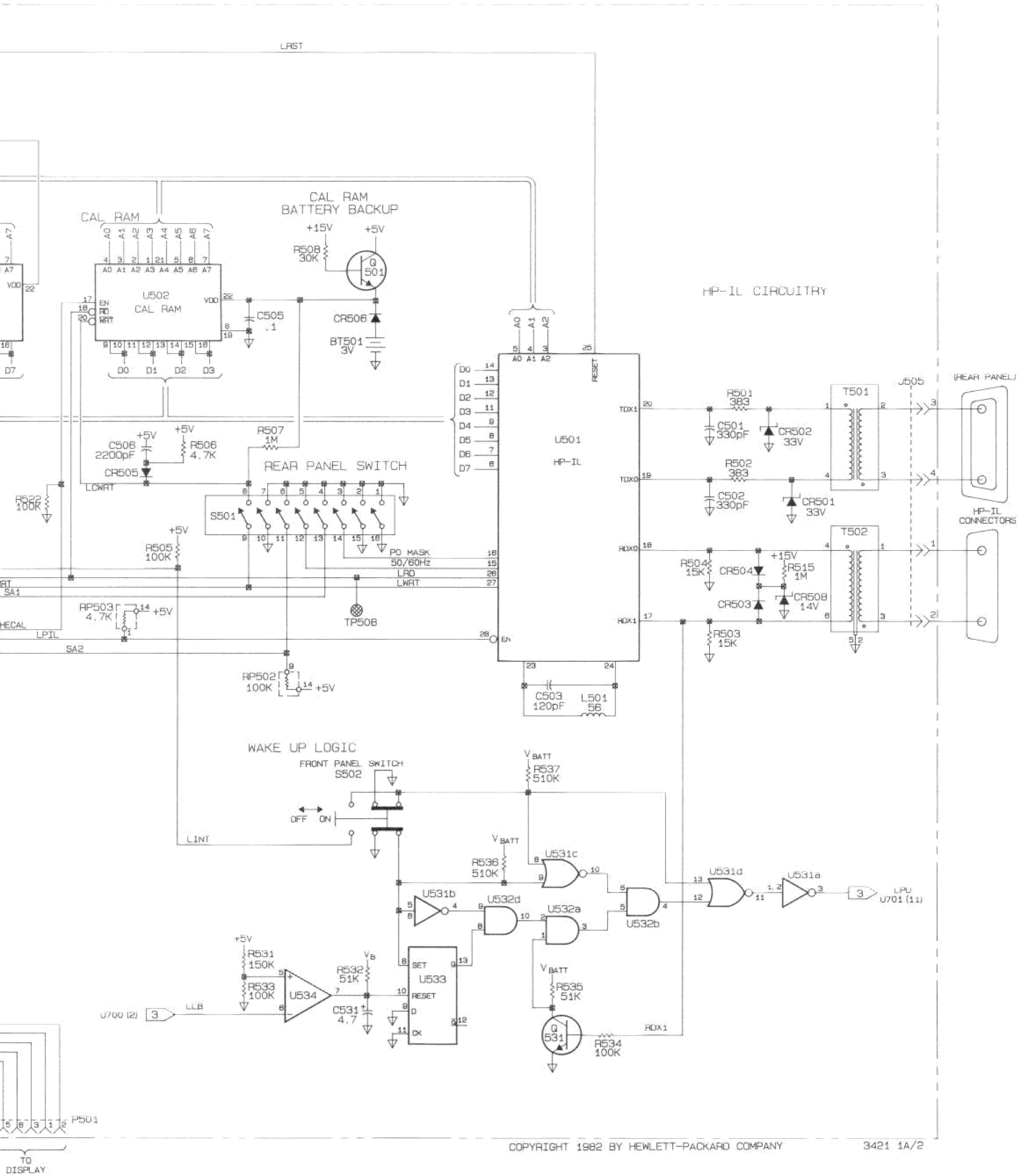



Figure 1-7-5. 03421-66501 Control Logic Schematic (Schematic 2)

## CHANGE 6

### Description

This changes the A1U401 part number. If the component replacement is required, use part number presently in Table 1-6-3

### Table 1-6-3 (Replaceable Parts) Changes

Do the changes in Table 1-6-3 as shown in Table 1-7-7.

**Table 1-7-7. Make Changes in Table 1-6-3 (Change 6)**

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: A1U401 | 1826-0059 | 2 | 1 | IC OP AMP GP TO-99 PKG |

## CHANGE 7

### Description

This change modifies the power supply circuitry, ohms input circuitry, and the Wake Up Logic circuitry (part of the control logic circuitry). It also changes the ROMs U505 and U506 part number. These ROM part numbers are not interchangeable with the ROMs presently listed in Table 1-6-3. They are also no longer available. When any ROM replacement is required, use the ROMs presently listed in Table 1-6-3. When doing this, the ohms input circuitry needs to be modified as presently shown on Schematic 1 in Service Group H. A Replacement/Update kit is available with the new ROMs. It includes the necessary parts and instructions. Order this kit for any ROM replacement. You can order it from Hewlett-Packard using part number 03421-87901.

### Section III, Operation Changes

Because of the extensive circuitry changes of the Wake Up Logic, the older instrument's battery operation is different than presently explained in the chapter. Change paragraph 1-3-7 in Section III to the following.

1-3-7. The instrument can be operated from its internal battery for 12 hours, when HP-IL is the interface, or for six hours if it is HP-IB, assuming the battery has a full charge when portable operation begins. If the battery is low (<5.8V), the instrument will power down approximately three seconds after turn on. If the battery goes below 5.8V during operation, the instrument will power down in approximately three minutes after detecting the low battery. The battery is charged automatically when the instrument is connected to the ac line. A discharged battery that is between 1V and 5.8V can take up to 16 hours to fully charge with the front panel switch off. When the switch is on, it takes about 21 hours to charge if the HP 3421A has HP-IL and longer if equipped with HP-IB. A fully discharged battery (<1V) can take up to 48 hours to charge.

### Schematic 1 (Input Circuitry) Changes

Do the following changes on Schematic 1 located in Service Group H.

Delete C205 from the junction of L201 and R204.

### Schematic 2 (Control Logic) Changes

Use the schematic in Figure 1-7-7 instead of Schematic 2 in Service Group H.

### Schematic 3 (Power Supply) Changes

Use the schematic in Figure 1-7-8 in place of Schematic 3 in Service Group H.

### Component Locator Changes

Use the component locator in Figure 1-7-6 instead of the locator in Service Group H.

### Table 8-E-2 (ROM Data Bus Signatures) Changes

Use the table shown in Table 1-7-8.

**Table 1-7-8. Change Table 8-E-2 (Change 7)**

| +5V Signature: 3428 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| D0 | Data Bit 0 | U505(9) | 5F51 | U506(9),U504(9,10), U502(9,10),U501(14), U508(12),U507(18), E501(3,14),RP501(3) |
| D1 | Data Bit 1 | U505(10) | A6A9 | U506(10),U504(11,12), U502(11,12),U501(13), U508(13), U507(17), E501(4,13), RP501(4) |
| D2 | Data Bit 2 | U505(11) | C8FA | U506(11),U504(13,14), U502(13,14),U501(12), U508(14),U507(14), E501(7,10),RP501(7) |
| D3 | Data Bit 3 | U505(13) | 313A | U506(13),U504(15,16), U502(15,16),U501(11), U508(15),U507(13), E501(8,9),RP501(8) |
| D4 | Data Bit 4 | U505(14) | CA41 | U506(14),U503(9,10), U501(9),U508(16), U507(8),E501(6,11), RP501(6) |
| D5 | Data Bit 5 | U505(15) | U4P1 | U506(15),U503(11,12), U501(8),U508(17), U507(7),E501(5,12), RP501(5) |
| D6 | Data Bit 6 | U505(16) | 7P09 | U506(16),U503(13,14), U501(7),U508(18), U507(3),E501(1,16), RP501(1) |
| D7 | Data Bit 7 | U505(17) | FCUC | U506(17),U503(15,16), U501(6),U508(19), U507(4),E501(2,15), RP501(2) |

### Table 1-6-3 (Replaceable Parts) Changes

Do the changes in Table 1-6-3 as shown in Table 1-7-9.

**Table 1-7-9. Make Changes in Table 1-6-3 (Change 7)**

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Delete: | | | | |
| A1C205 | 0170-0021 | 6 | 1 | CAPACITOR-FXD 4700PF ±10% 400VDC POLYP |
| A1C722 | 0180-0197 | 8 | | CAPACITOR-FXD 2.2UF ±10% 20VDC TA |
| A1C723 | 0180-0197 | 8 | | CAPACITOR-FXD 2.2UF ±10% 20VDC TA |
| A1C724 | 0180-0228 | 6 | | CAPACITOR-FXD 22UF ±10% 15CDC TA |
| A1CR584 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| A1Q708 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ |
| A1R587 | 0698-8777 | 3 | | RESISTOR 1K 5% .25W CC TC=-400/+800 |
| A1R733 | 0698-3228 | 9 | | RESISTOR 19.9K 1% .125W F TC=0±100 |
| A1R734 | 0757-0472 | 5 | | RESISTOR 200K 1% .125W F TC=0±100 |
| A1R735 | 0683-5145 | 6 | | RESISTOR 510K 5% .25W FC TC=-800/+900 |
| A1R736 | 0698-4486 | 3 | | RESISTOR 24.9K 1% .125W F TC=0±100 |
| Change: | | | | |
| A1C304 | 0180-0228 | 6 | 2 | CAPACITOR-FXD 22UF ±10% 15VDC TA |
| A1C703 | 0180-0197 | 8 | 3 | CAPACITOR-FXD 2.2UF ±10% 20VDC TA |
| A1CR300 | 1901-0050 | 3 | 15 | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| A1CR501 | 1902-0970 | 8 | 2 | DIODE-ZNR 33V 5% DO-D5 PD= +.097% |
| A1CR502 | 1902-0970 | 8 | | DIODE-ZNR 33V 5% DO-D5 PD= +.097% |
| A1Q504 | 1854-0071 | 7 | 5 | TRANSISTOR NPN SI PD=300MW FT=200MHZ |
| A1R406 | 0698-3228 | 9 | 3 | RESISTOR 19.9K 1% .125W F TC=0±100 |
| A1R536 | 0683-5145 | 6 | 2 | RESISTOR 510K 5% .25W FC TC=-800/+900 |
| A1R713 | 0698-4486 | 3 | 1 | RESISTOR 24.9K 1% .125W F TC=0±100 |
| A1U505 | 1818-3079 | 5 | 1 | IC-ROM 64K (3421A) |
| A1U506 | 1818-3080 | 8 | 1 | IC-ROM 64K (3421A) |

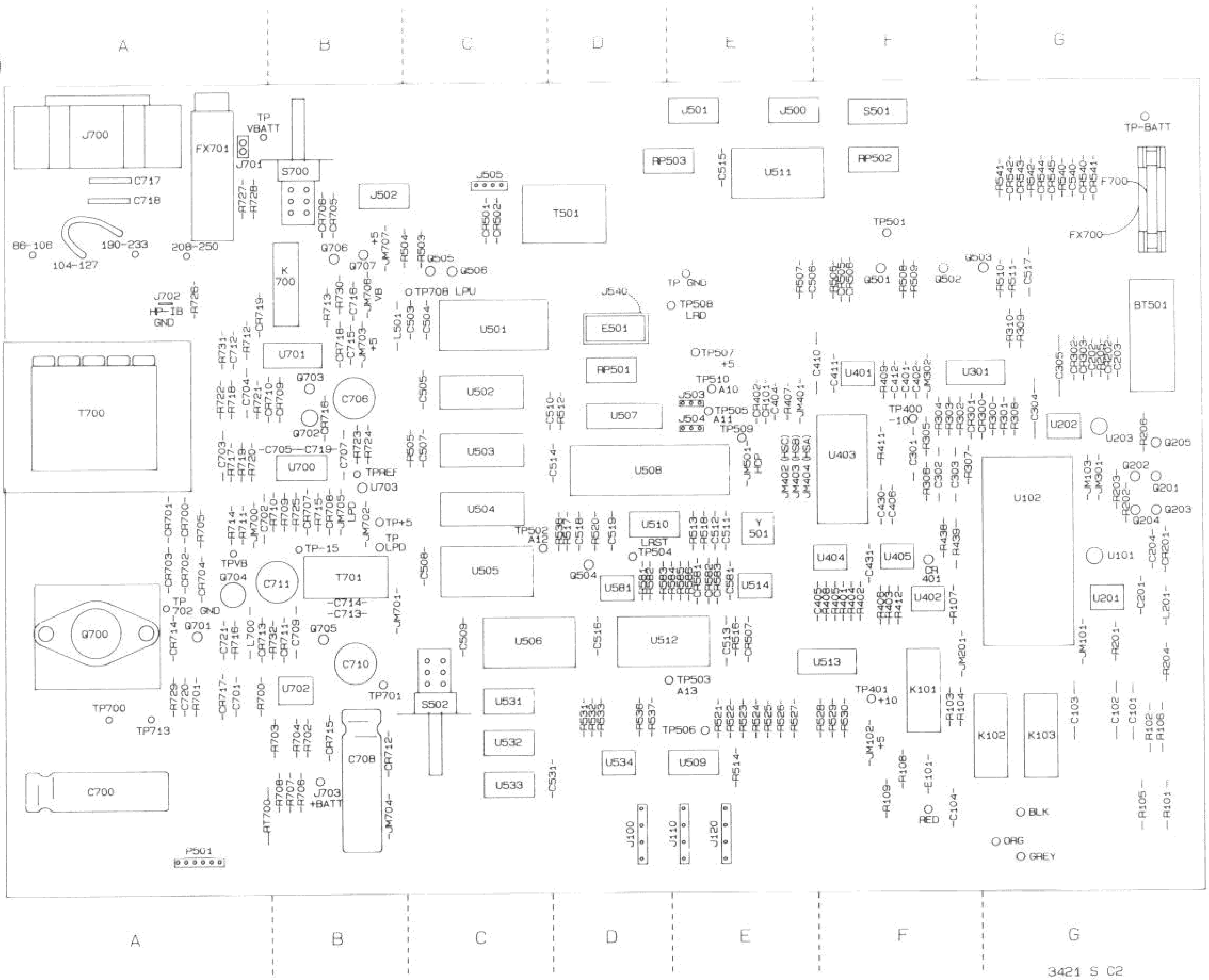


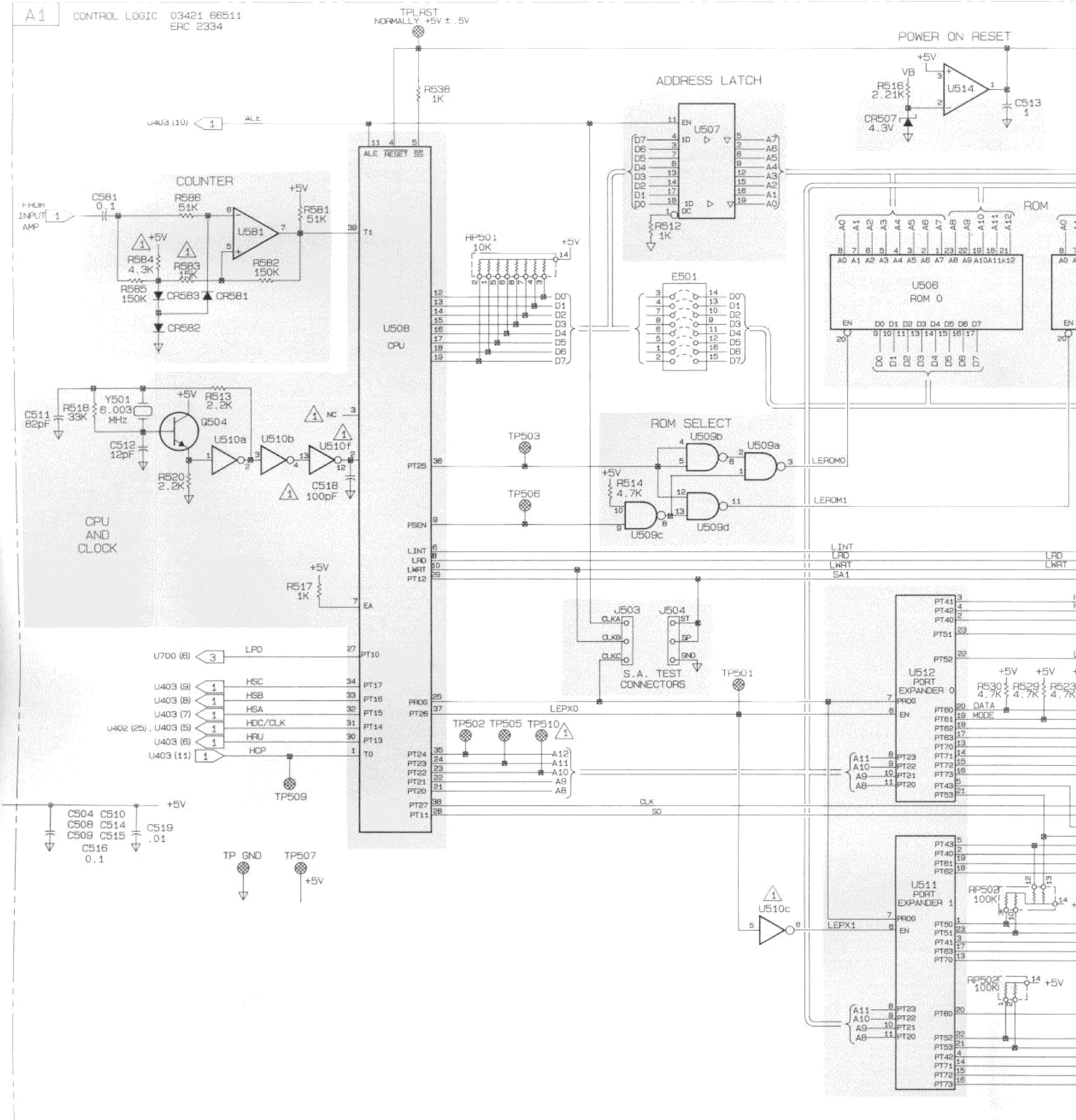
Figure 1-7-6. 03421-66511 Component Locator (ERC 2334)

## IC Power Supply Configurations for Schematic 2

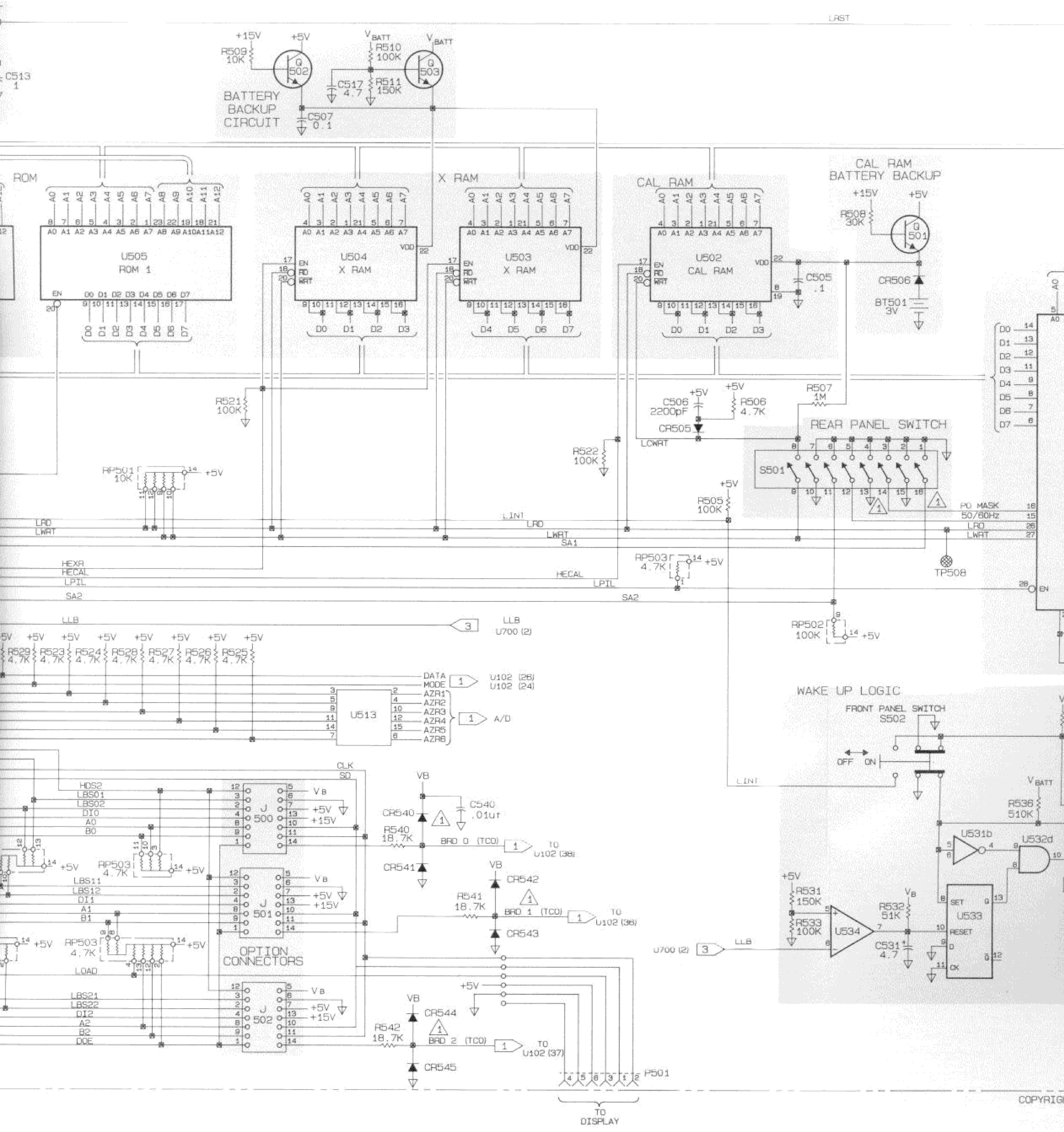
| IC # | Type | -hp- P/N | RAW | +15V | −15V | VB | VBATT | +5V | GND |
|---|---|---|---|---|---|---|---|---|---|
| U501 | HP-IL | 1LB3-0003 | — | — | — | — | — | 1,2,21,22 | 10 |
| U502 | UPD5101 | 1818-1754 | — | — | — | — | — | 22 | 8,19 |
| U503 | UPD5101 | 1818-1754 | — | — | — | — | 22 | 22 | 8,19 |
| U504 | UPD5101 | 1818-1754 | — | — | — | — | 22 | 22 | 8,19 |
| U505 | 64k ROM | 1818-3079 | — | — | — | — | — | 24 | 12 |
| U506 | 64k ROM | 1818-3080 | — | — | — | — | — | 24 | 12 |
| U507 | 74LS373 | 1820-2102 | — | — | — | — | — | 20 | 10 |
| U508 | 8039 CPU | 1820-2718 | — | — | — | — | — | 40,26 | 20 |
| U509 | 74LS00 | 1820-1197 | — | — | — | — | — | 14 | 7 |
| U510 | 74LS04 | 1820-1199 | — | — | — | — | — | 14 | 7 |
| U511 | 8243 | 1820-2177 | — | — | — | — | — | 24 | 12 |
| U512 | 8243 | 1820-2177 | — | — | — | — | — | 24 | 12 |
| U513 | MC14050 | 1820-1146 | — | — | — | — | — | 1 | 8 |
| U514 | LM393 | 1826-0412 | — | 8 | — | — | — | — | 4 |
| U531 | MC14001 | 1820-1745 | — | — | — | 14 | — | — | 7 |
| U532 | MC14081 | 1820-1486 | — | — | — | 14 | — | — | 7 |
| U533 | MC14013 | 1820-0939 | — | — | — | 14 | — | — | 7 |
| U534 | LM393 | 1826-0412 | — | — | — | — | — | 8 | 4 |
| U581 | LM393 | 1826-0412 | — | — | — | — | — | 8 | 4 |

## Grid Locator For Schematic 2 Components

| Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column |
|---|---|---|---|---|---|---|---|
| BT501 | G | CR581 | E | R517 | D | S502 | C |
| C503 | C | CR582 | E | R518 | E | T501 | C-D |
| C504 | C | CR583 | E | R520 | D | TP501 | F |
| C505 | C | E501 | D | R521 | E | TP502 | C |
| C506 | E | J500 | E | R522 | E | TP503 | D |
| C507 | C | J501 | E | R523 | E | TP504 | D |
| C508 | C | J502 | B | R524 | E | TP505 | E |
| C509 | C | J503 | E | R525 | E | TP506 | E |
| C510 | D | J504 | E | R526 | E | TP507 | E |
| C511 | E | J505 | C | R527 | E | TP508 | D-E |
| C512 | E | J540 | D | R528 | E-F | TP509 | E |
| C513 | E | L501 | B | R529 | F | TP510 | E |
| C514 | D | P501 | A | R530 | F | U501 | C |
| C515 | E | Q501 | F | R531 | D | U502 | C |
| C516 | D | Q502 | F | R532 | D | U503 | C |
| C517 | G | Q503 | F | R533 | D | U504 | C |
| C518 | D | Q504 | E | R536 | D | U505 | C |
| C519 | D | Q505 | C | R537 | D | U506 | C |
| C531 | E-D | Q506 | C | R538 | D | U507 | D |
| C540 | G | R503 | C | R540 | G | U508 | D-E |
| C581 | E | R504 | B-C | R541 | G | U509 | E |
| CR501 | C | R505 | C | R542 | G | U510 | E |
| CR502 | G | R506 | F | R581 | D | U511 | E |
| CR505 | F | R507 | E | R582 | D | U512 | D-E |
| CR506 | F | R508 | F | R583 | D | U513 | E-F |
| CR507 | E | R509 | F | R584 | D-E | U514 | E |
| CR540 | G | R510 | G | R585 | E | U531 | C |
| CR541 | G | R511 | G | R586 | E | U532 | C |
| CR542 | G | R512 | D | RP501 | D | U533 | C |
| CR543 | G | R513 | E | RP502 | F | U534 | D |
| CR544 | G | R514 | E | RP503 | D-E | U581 | D |
| CR545 | G | R516 | E | S501 | F | Y501 | E |

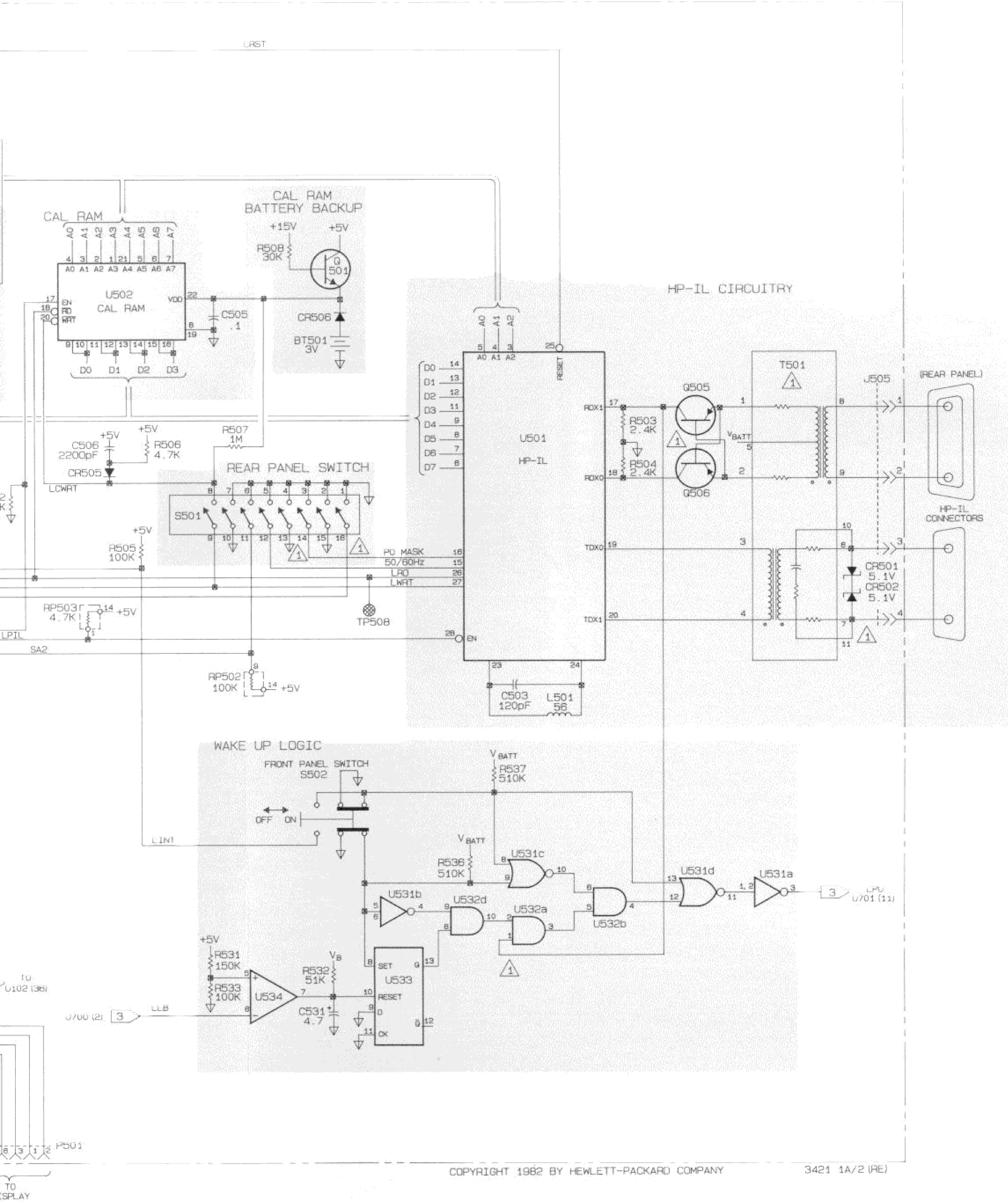



THIS INDICATES A CHANGE FROM THE ORIGINAL DESIGN



BATTERY BACKUP CIRCUIT
R509 10K
Q502
Q503
R510 100K
R511 150K
C517 4.7
C507 0.1
C513 1
LRST
ROM
U505 ROM 1
X RAM
U504 X RAM
U503 X RAM
CAL RAM
U502 CAL RAM
C505 .1
CAL RAM BATTERY BACKUP
R508 30K
Q501
CR506
BT501 3V
R521 100K
R522 100K
C506 2200pF
CR505
R506 4.7K
R507 1M
REAR PANEL SWITCH
S501
R505 100K
RP501 10K
RP503 4.7K
RP502 100K
LCWRT
LRD
LWRT
LINT
SA1
SA2
HEXR
HECAL
LPIL
LLB
PD MASK
50/60Hz
TP508
LLB U700 (2)
R529 4.7K
R523 4.7K
R524 4.7K
R528 4.7K
R527 4.7K
R526 4.7K
R525 4.7K
DATA
MODE
U102 (26)
U102 (24)
U513
AZR1
AZR2
AZR3
AZR4
AZR5
AZR6
A/D
WAKE UP LOGIC
FRONT PANEL SWITCH S502
OFF ON
R536 510K
U531b
U532d
R531 150K
R533 100K
U534
R532 51K
C531 4.7
U533
SET
RESET
U700 (2)
CLK
SD
HDS2
LBS01
LBS02
DI0
A0
B0
J 500
J 501
J 502
LBS11
LBS12
DI1
A1
B1
LOAD
LBS21
LBS22
DI2
A2
B2
DOE
OPTION CONNECTORS
C540 .01uf
CR540
R540 18.7K
BRD 0 (TCO)
TO U102 (38)
CR541
CR542
R541 18.7K
BRD 1 (TCO)
TO U102 (36)
CR543
CR544
R542 18.7K
BRD 2 (TCO)
TO U102 (37)
CR545
P501
TO DISPLAY
COPYRIGI


Figure 1




3421 1A/2 (RE)

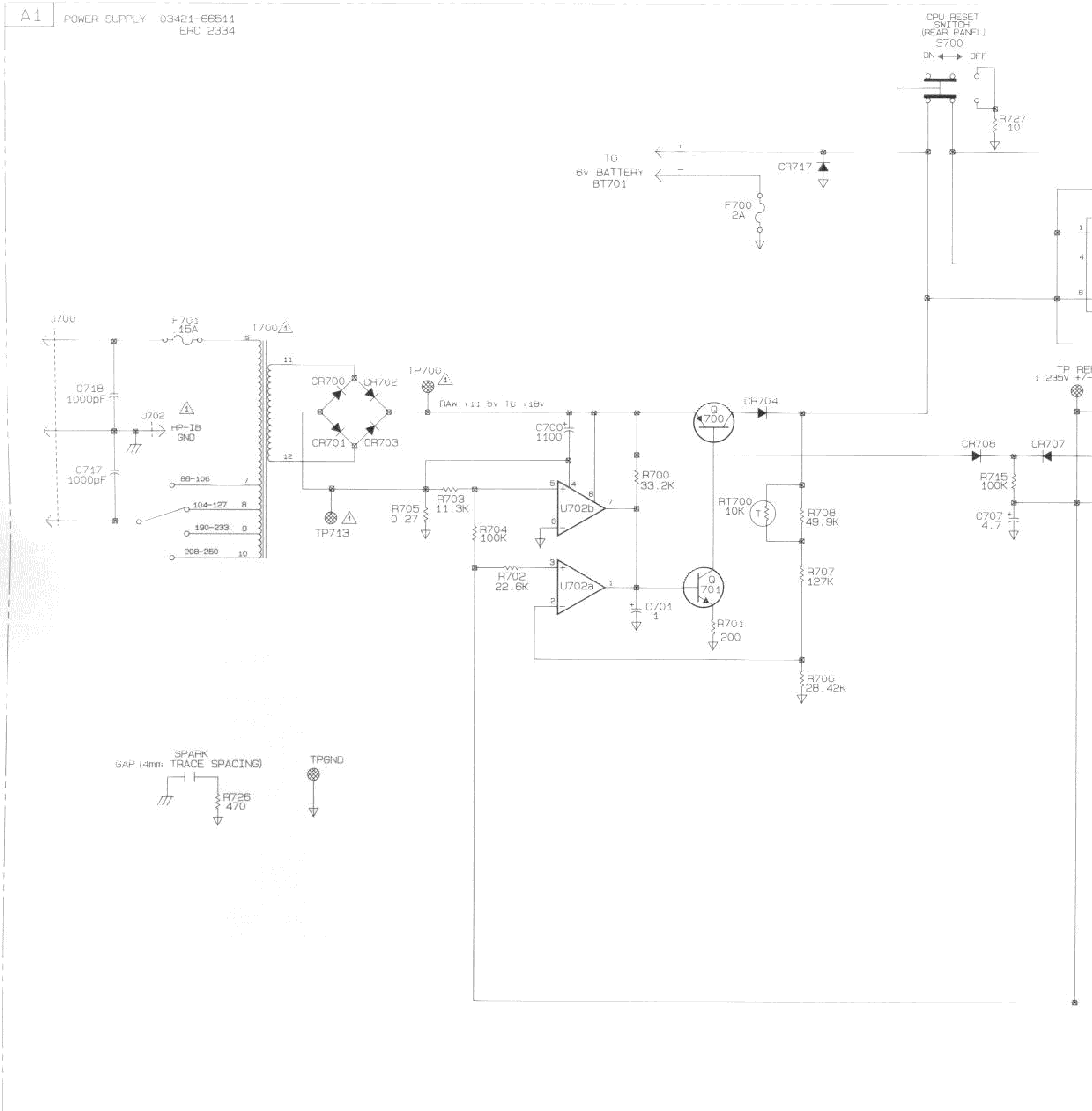
Figure 1-7-7. 03421-66511 Control Logic Schematic (Schematic 2)
with ERC 2334

## IC Power Supply Configurations for Schematic 3

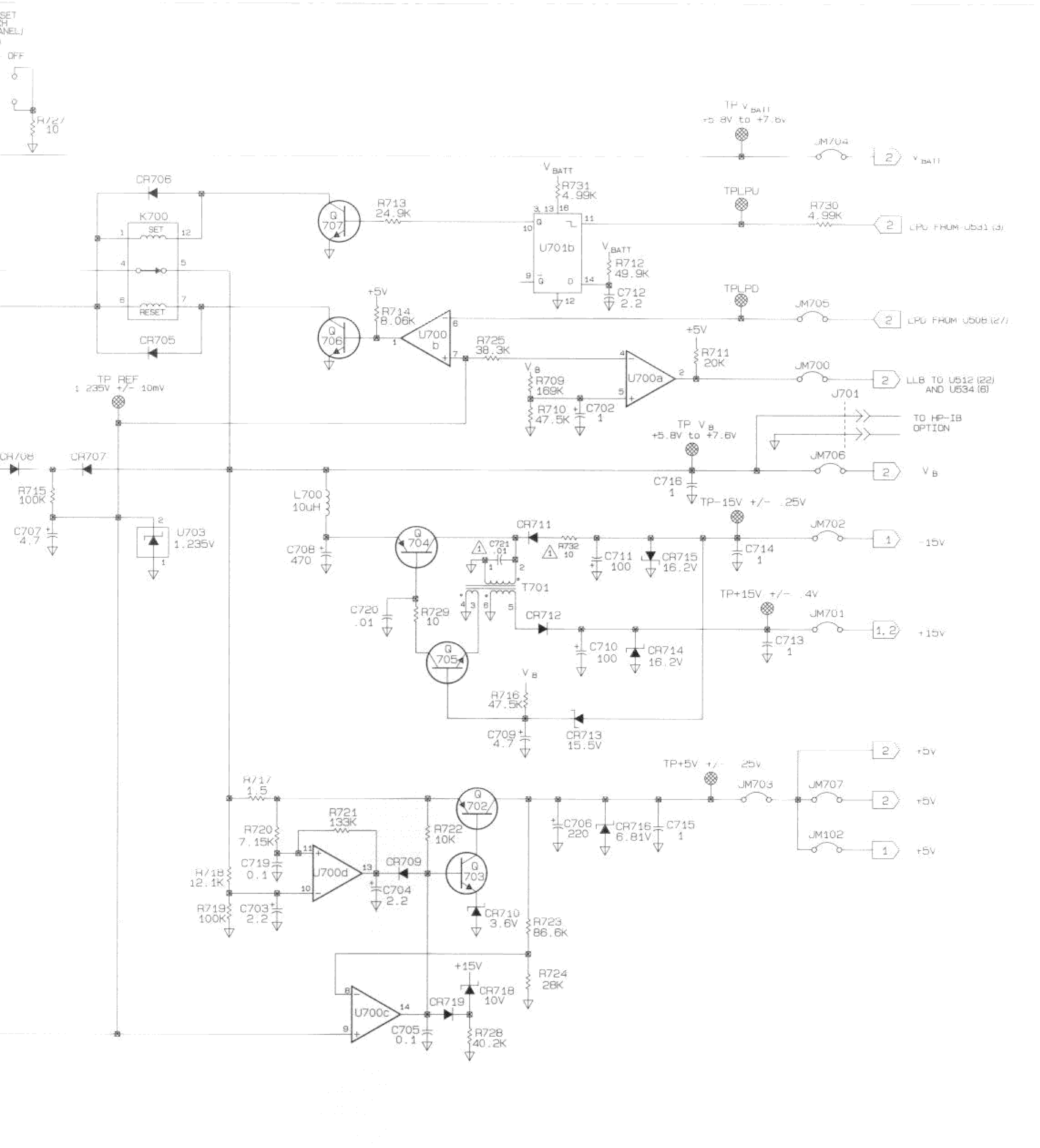
| IC # | Type | -hp- P/N | RAW | +15V | −15V | VB | VBATT | +5V | GND |
|---|---|---|---|---|---|---|---|---|---|
| U700 | MC3302 | 1826-0174 | – | 3 | – | – | – | – | 12 |
| U701 | MC14538 | 1820-1932 | – | – | – | – | 3,13,16 | – | 1,4,5,8,12,15 |
| U702 | LM393 | 1826-0412 | 8 | – | – | – | – | – | 4 |

## Grid Locator For Schematic 3 Components

| Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column |
|---|---|---|---|---|---|---|---|
| C700 | A | CR708 | B | Q701 | A | R723 | B |
| C701 | A | CR709 | B | Q702 | B | R724 | B |
| C702 | A | CR710 | A-B | Q703 | B | R725 | B |
| C703 | A | CR711 | B | Q704 | A | R726 | A |
| C704 | A | CR712 | B | Q705 | B | R727 | A |
| C705 | B | CR713 | A-B | Q706 | B | R728 | A |
| C706 | B | CR714 | A | Q707 | B | R729 | A |
| C707 | B | CR715 | B | R700 | A | R730 | B |
| C708 | B | CR716 | B | R701 | A | R731 | A |
| C709 | B | CR717 | A | R702 | B | R732 | B |
| C710 | B | CR718 | B | R703 | B | RT700 | A-B |
| C711 | A-B | CR719 | A | R704 | B | S700 | B |
| C712 | A | F700 | G | R705 | A | T700 | A |
| C713 | B | FX700 | G | R706 | B | T701 | B |
| C714 | B | FX701 | A | R707 | B | TP+5V | B |
| C715 | B | J700 | A | R708 | B | TP+15V | B |
| C716 | B | J701 | A | R709 | B | TP−15V | B |
| C717 | A | J702 | A | R710 | B | TPBATT | G |
| C718 | A | JM102 | F | R711 | A | TPLPD | B |
| C719 | B | JM700 (LLB) | A | R712 | A | TPLPU | B |
| C720 | A | JM701 (+15) | B | R713 | B | TPREF | B |
| C721 | A | JM702 (−15) | B | R714 | A | TPVB | A |
| CR700 | A | JM703 (+5) | B | R715 | B | TPVBATT | A |
| CR701 | A | JM704(VBATT) | B | R716 | A | TP700 | A |
| CR702 | A | JM705 (LPD) | B | R717 | A | TP713 | A |
| CR703 | A | JM706 (VB) | B | R718 | A | U700 | B |
| CR704 | A | JM707 | B | R719 | A | U701 | B |
| CR705 | B | K700 | B | R720 | A | U702 | B |
| CR706 | B | L700 | A | R721 | A | U703 | B |
| CR707 | B | Q700 | A | R722 | A | | |




THIS INDICATES A CHANGE FROM THE ORIGINAL DESIGN






3421 1A/3 (RE)

Figure 1-7-8. 03421-66511 Power Supply Schematic (Schematic 3) with ERC 2334

## CHANGE 8

### Description

This change applies to the control logic and power supply circuitry of the instrument. The change includes changing the value of R587 in the Wake Up Logic and changing the value of R734 in the power supply circuitry. If R587 and/or R734 is to be replaced, use the values presently in Table 1-6-3.

### Schematic 2, Control Logic Changes

Do the following change on Schematic 2 in Service Group H.

Change the value of R587 from 10K to 1K.

### Schematic 3 (Power Supply) Changes

Do the following change on Schematic 3 in Service Group H.

Change the value of R734 from 402K to 200K.

### Table 1-6-3 (Replaceable Parts) Changes

Do the changes in the Table 1-6-3 as shown in Table 1-7-10.

**Table 1-7-10. Make Changes in Table 1-6-3 (Change 8)**

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: | | | | |
| A1R404 | 0757-0472 | 5 | 2 | RESISTOR 200K 1% .125W F TC=0±100 |
| A1R512 | 0698-8777 | 3 | 4 | RESISTOR 1K 5% .25W CC TC=−400/+900 |
| A1R587 | 0698-8777 | 3 | | RESISTOR 1K 5% .25W CC TC=−400/+900 |
| A1R734 | 0757-0472 | 3 | | RESISTOR 200K 1% .125W F TC=0±100 |

## CHANGE 9

### Description

Instruments with serial numbers 2338A04275 and below had different top and bottom shells. For those instruments where the replacement of either the top or bottom shell is required, replace both top and bottom shells with the part numbers presently listed in Figure 1-6-1 (see Section VI). You can order a retrofit kit under HP Part Number 03421-68701 to simplify the shell replacement. Since the kit contains all the necessary parts for retrofitting older instruments, HP suggests ordering the kit for any necessary replacement.

### Figure 1-6-1 (Miscellaneous Parts) Changes

Do the changes in the table in Figure 1-6-1 as shown in Table 1-7-11.

**Table 1-7-11. Make Changes in the Table in Figure 1-6-1 (Change 9)**

| Index/Ref. Number | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: | | | | |
| 2 | 4040-2040 | 3 | 1 | SHELL-MOLDED (TOP) |
| 36 | 0515-0754 | 4 | 6 | SCREW-PH M3.5 X 70 LK |
| 39 | 4040-2141 | 4 | 1 | SHELL-BOTTOM 425.5-MM-WD |
| Add: | | | | |
| 36 | 3050-0010 | 2 | 6 | WASHER-FL MTLC NO. 6 .147-IN-ID |

## CHANGE 10

### Description

This change applies to instruments with ERC numbers 2417 and below. It also applies to instruments with serial numbers 2338A3052 thru 2338A03036. It involves changing the A1U201, A1U202, and A1U401 part number in Table 1-6-3. If any replacement of these components are required, use the part numbers presently in Table 1-6-3.

### Table 1-6-3 (Replaceable Parts) Changes

Do the changes in the Table 1-6-3 as shown in Table 1-7-12.

**Table 1-7-12. Make Changes in Table 1-6-3 (Change 10)**

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: | | | | |
| A1U201 | 5180-0269 | 0 | 2 | IC OP AMP LOW-BIAS-H-IMPD 8-DIP-P PKG |
| A1U201 | 5180-0269 | 0 | | IC OP AMP LOW-BIAS-H-IMPD 8-DIP-P PKG |
| A1U203 | 5180-0268 | 1 | 1 | IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG |
| A1U401 | 5180-0270 | 3 | 1 | IC OP AMP TO-99 PKG |

## CHANGE 11

### Description

This change applies to instruments with ERC numbers 2505 and below, and serial numbers 2338A05625 and below. These instruments had different standoffs for the A1U102 Hybrid. Therefore, use the hybrid mounting screws shown in Table 1-7-13 for A1 motherboards (P/N 03421-66501 and 03421-66511) with ERC numbers 2505 and below.

### Figure 1-6-1 (HP 3421A Miscellaneous and Mechanical Parts)

Do the changes in the table in Figure 1-6-1 as shown in Table 1-7-13.

**Table 1-7-13. Make Changes in Figure 1-6-1 (Change 11)**

| Index/Ref Number | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: 18 | 0515-0055 | 8 | 2 | SCREW-MACH M3 X 0.5 6MM-LG PAN-HD |

## CHANGE 12

### Description

This change applies to instruments with ERC numbers 2518 and below, and serial numbers 2338A06935 and below. These instruments had a different input protection circuit for the A1U102 Hybrid. If the hybrid appears to fail due to high input voltage transients, use the circuit configuration and part numbers presently shown in Schematic 1, Service Group H. The following information is only supplied to update this manual for instruments requiring Change 12.

### Schematic 1 (Input Circuitry) Changes

Do the following changes on Schematic 1 in Service Group H.

Change the value of E101 from 550V to 630V.
change VR101 to C104, a .01$\mu$F Capacitor.

### Table 1-6-3 (Replaceable Parts) Changes

Do the changes in the table in Table 1-6-3 as shown in Table 1-7-14.

**Table 1-7-14. Make Changes in Table 1-6-3 (Change 12)**

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Delete: A1VR101 7 | 0837-0318 | 8 | 1 | VOLTAGE SUPPRESSOR |
| Change: A1E101 | 1970-0090 | 6 | 1 | TUBE-ELECTRON SURGE V PTCTR |
| Add: A1C104 7 | 0150-0012 | 3 | 1 | CAPACITOR-FXD .01UF ±20% 1KVDC CER |

# SECTION VIII
# SERVICE

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 1-8-1. INTRODUCTION

1-8-2. This section contains troubleshooting and repair information for the HP 3421A and is arranged in service groups. Information for selecting the proper service group is given starting with paragraph 1-8-15. Service Group A through F contain troubleshooting information for different functional areas of the instrument, Service Group G has the complete theory of operation, and Service Group H has a mnemonic table, detailed block diagram, component locator, and schematics.

1-8-3. The first part of this section is separated as follows:

a. Safety Considerations - paragraph 1-8-4.
b. Recommended Test Equipment - paragraph 1-8-9.
c. Replacing Fuses - paragraph 1-8-11.
d. Troubleshooting - paragraph 1-8-15.

  1. Introduction - paragraph 1-8-16.
  2. Check the Obvious First - paragraph 1-8-18.
  3. Self Test - paragraph 1-8-21.
  4. Service Group Selection - paragraph 1-8-28.

e. Troubleshooting Setup - paragraph 1-8-36.

1. Disassembly - paragraph 1-8-38.
2. Reassembly - paragraph 1-8-40.

f. Strain relief - paragraph 1-8-44.

## 1-8-4. SAFETY CONSIDERATIONS

**WARNING**

*Any interruptions of the protective grounding conductor (inside or outside the instrument), or disconnections of the protective earth terminal can make the instrument dangerous and is strictly prohibited.*

*The service information given in this manual is normally used with the instrument's protective cover removed and with power applied. Voltages at many points may be hazardous. This instrument should only be serviced by a qualified service person aware of the hazards involved.*

1-8-5. The HP 3421A has been designed in accordance with international safety standards. To maintain these standards, all cautions, warnings, and other safety related information must be followed when servicing the instrument.

1-8-6. Most repairs will require that the top cover be removed and power applied. Voltage or signals at many points may, if contacted, result in personal injury. Therefore, service should be performed by a qualified service person who is aware of the hazards involved.

1-8-7. It is possible for capacitors inside the instrument to remain charged when the instrument has been powered down or its power source disconnected.

1-8-8. Make sure that only the recommended fuse type (fast blow, correct current rating, etc.) is used for replacement. Never use repaired fuses and never short circuit the fuse holders.

## 1-8-9. RECOMMENDED TEST EQUIPMENT

1-8-10. The recommended test equipment that is required for a particular service group is listed in that service group. The procedures outlined for selecting the various service groups does not require any test equipment.

## 1-8-11. REPLACING FUSES

1-8-12. The HP 3421A has two fuses, a line fuse (F701) and a main battery fuse (F700). The battery fuse is required anytime the instrument is on battery operation, the battery is being charged from the ac line, or on instruments with a Serial Number Prefix below 2338. The line fuse is required whenever the main battery is charged or the instrument is operated from the ac line.

1-8-13. The line fuse can be accessed by unscrewing the fuse holder on the rear panel as shown in Figure 1-8-1. The replacement fuse must be a .15A slow blow (HP Part Number 2110-0320).

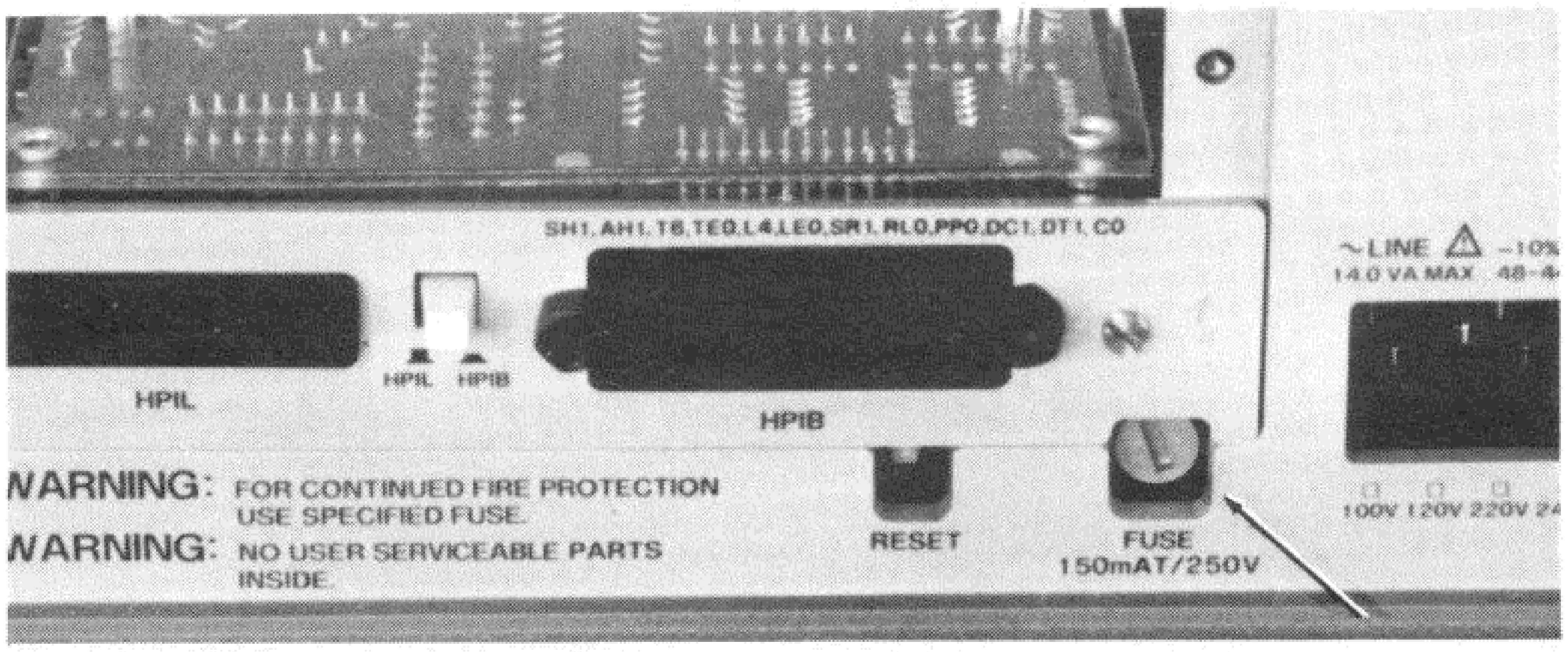



**Figure 1-8-1. Replacing the Line Fuse**

1-8-14. To replace the main battery fuse, the top cover must be removed (see paragraph 1-8-38). The procedure to remove the top cover is explained in the disassembly procedure. The fuse is located toward the rear and the right of the instrument as shown in Figure 1-8-2. Replacement fuses must be 2A normal blow (HP Part Number 2110-0002).

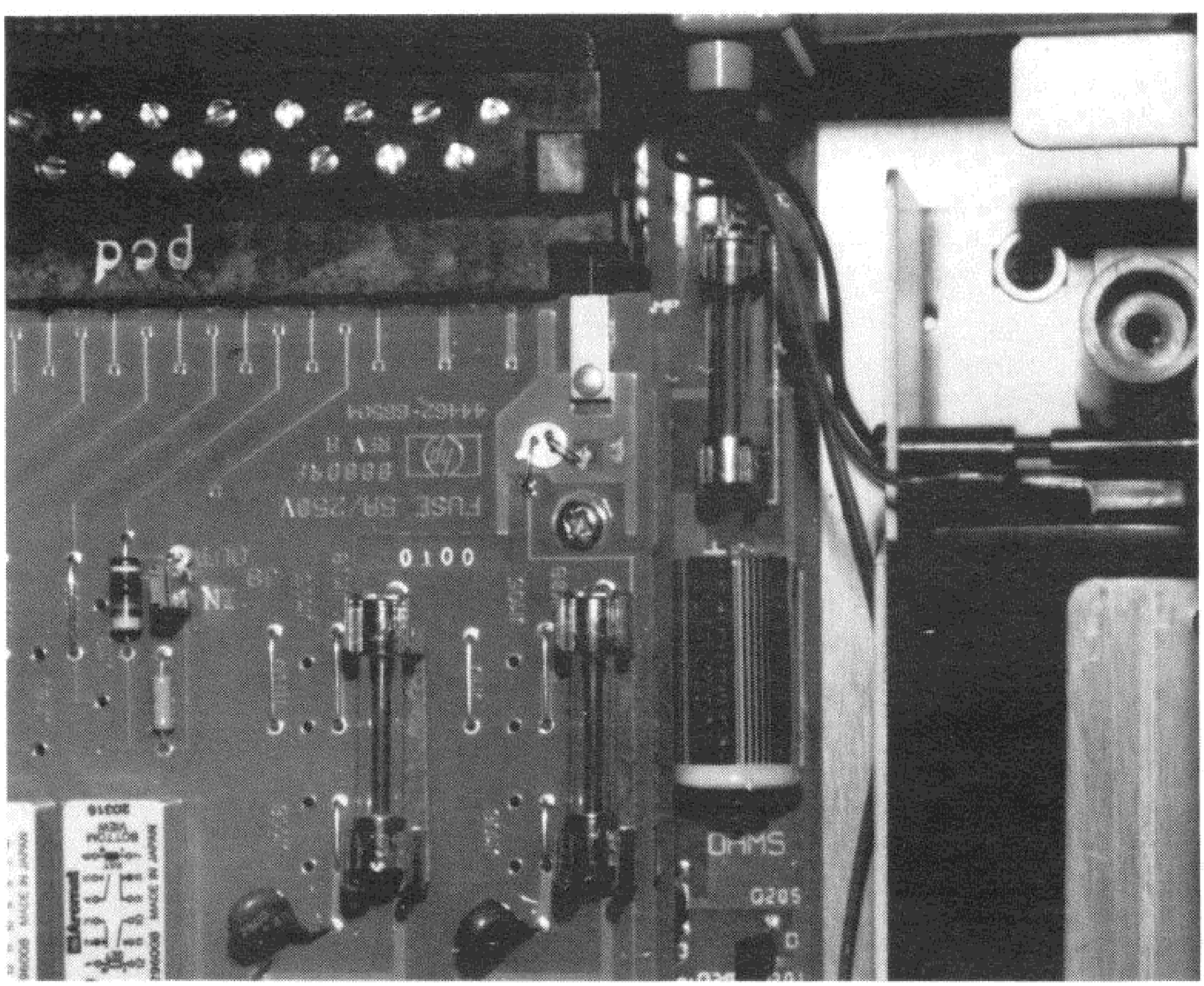



**Figure 1-8-2. Replacing the Main Battery Fuse**

## 1-8-15. TROUBLESHOOTING

**CAUTION**

*This instrument contains CMOS Integrated Circuits which are susceptible to damage from static discharge. It is important that grounded tools and wrist straps be used when handling or troubleshooting these components.*

### 1-8-16. Introduction

1-8-17. The following paragraphs have information to assist you in selecting the proper service group.

### 1-8-18. Check The Obvious First

1-8-19. Before troubleshooting the HP 3421A, make sure the failure is the instrument rather than from an external connection (i.e., I/O connector to instrument and/or controller, option card connections, etc.).

1-8-20. Make sure that the cables for installed options are securely plugged into their respective sockets and there are no bent pins.

### 1-8-21. Self Test

1-8-22. The HP 3421A has a built in self test feature that has eight segments (0 thru 7). Self test is activated at power on, when a Device Clear (DCL or SDC), or RESET (RS) command is received from a controller. At power on, for example, the following sequence takes place. First, all segments of the display are turned on for about one second, followed by the display going blank, except for the power-on indicator. Next, any self test segment that fails is displayed for about one second (eg, 0, 1, 2, etc.). The self test segment that failed then turns off and the error indicator turns on. If any self test segment fails, the error indicator will stay on after self test is complete, but not the self test segment indicator. Figure 1-8-3 explains the various portions of the display that result from self test.

1-8-23. For a low main battery condition at power on, the display error indicator and display segment 27 turns on. The HP 3421A then powers down in about three seconds later.

**NOTE**

*If an HP-IB Option is installed and the HP-IB select switch (on the option) is pushed in, the HP-IB address is displayed immediately after any self test failure is displayed at power on. The address is also displayed when the rear panel reset button is pressed in and released. The HP-IB address does not appear when the RESET command is executed. Do not confuse the HP-IB address with a self test failure. Display segments for self test failures are 0 thru 7. A self test failures causes the error indicator to remain on in the display after self test is complete.*

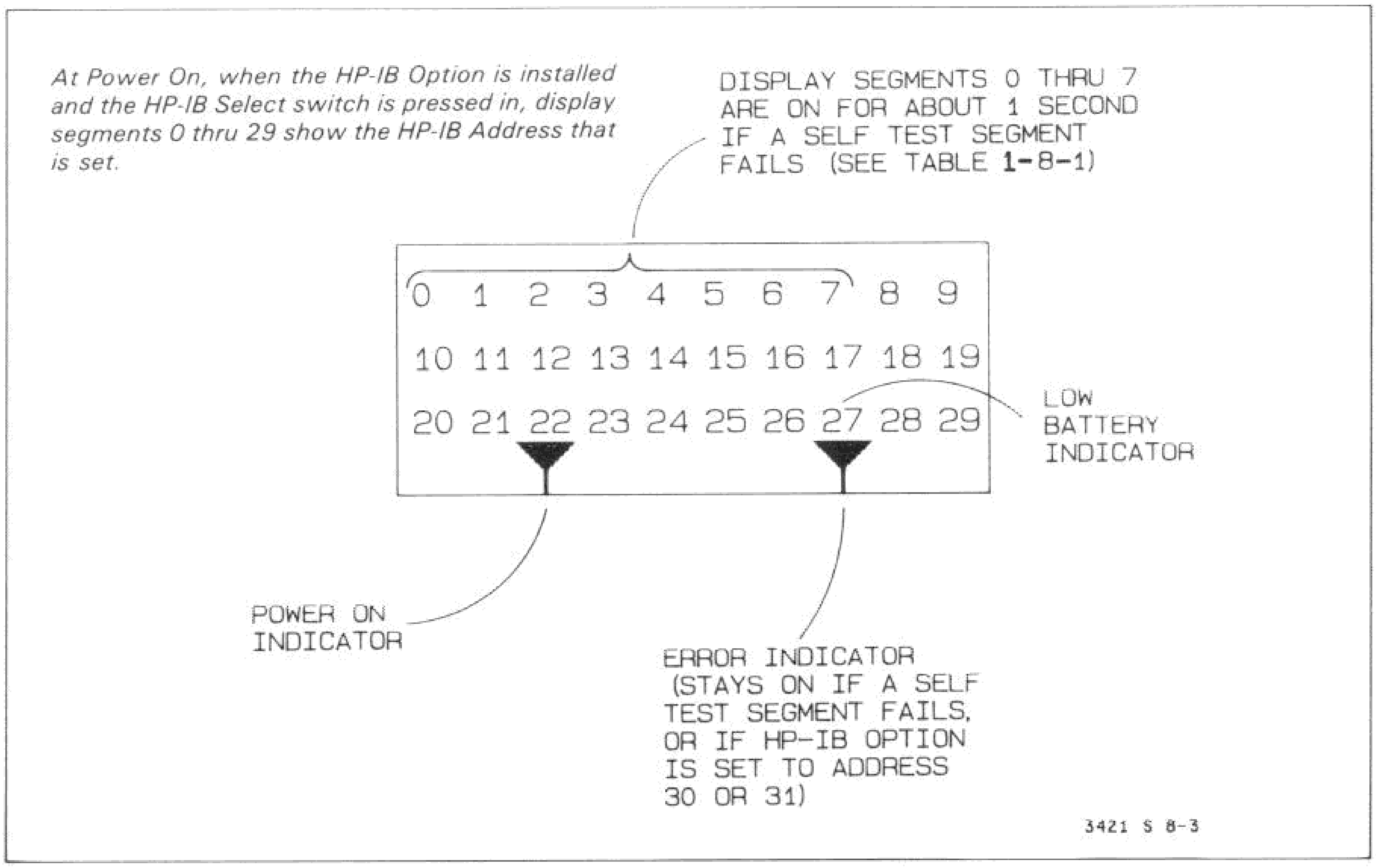



**Figure 1-8-3. Self Test Display**

1-8-24. In addition to the visual indication that takes place, a self test failure also causes the following. It sets bits 2, 5, and 6 of the HP 3421A status byte, sends the service request message to the controller, and sets certain bits in some of the state registers (dependent on the failure). State register information may or may not be useful to you for troubleshooting. They are, however, explained in Section III of this chapter if you wish to use them (see paragraph 1-3-43). Table 1-8-1 lists the various self test segments and also which bits are set in State Register #3 when a failure occurs. If a failure occurs, go to the appropriate service group which are also listed in Table 1-8-1.

**Table 1-8-1. Self Test Segments and Failures**

| Self Test Segment | Description | Service Group | Bit(s) Set SR #3 |
|---|---|---|---|
| 0 | Cal RAM Check Sum (U502) | E | 0 |
| 1 | ROM 1 Check Sum (U505) | E | 1 |
| 2 | ROM 0 Check Sum (U506) | E | 2 |
| 3 | A/D Slope Test | D | 3 |
| 4 | CPU RAM Check | E | 4 |
| 5 | RAM Check (U504) | E | 5 |
| 6 | RAM Check (U503) | E | 6 |
| 7* | 10 MΩ Test | C | 7 |

*Test Segment 7 checks for a 10 MΩ (± 20%) input resistance. If during the self test there are any connections on the front panel terminals or HI COMMON and LO COMMON of an installed Multiplex Assembly, the test segment will probably fail. To ensure proper circuitry operation, make sure these inputs have been disconnected before running self test.

### 1-8-25. Service Group Selection

1-8-26. The various service groups listed in Table 1-8-2 divide the instrument into functional areas for troubleshooting. Some of these functions are checked during self test, but not all functions. The primary purpose of self test is to check the various portions of the control logic, which may not necessarily guide you to the service group you need. If you are encountering a failure (and self test passes), use the following information to help select the proper service group.

**Table 1-8-2. HP 3421A Service Groups**

| Service Group | Title |
|---|---|
| A | DC Volts Troubleshooting |
| B | AC Volts Troubleshooting |
| C | Ohms Troubleshooting |
| D | A/D Converter |
| E | Control Logic |
| F | Power Supply |
| G | Theory of Operation |
| H | Mnemonics, Block Diagram, Component Locator and Schematics |

1-8-27. As noted in Table 1-8-2, Service Groups A through F contain the troubleshooting information for the instrument, while Service Groups G and H contain the Theory of Operation and Schematics, respectively. A particular Service Group is selected according to failure. The following paragraphs list possible failures, general troubleshooting information, and corresponding service group(s).

**1-8-28. DC Volt Failures (Service Group A).** Typical dc volt failures include overload, inaccurate, constant zero, floating, or noisy readings. These are explained as follows:

*a. Overload.* An overload is a reading that is larger (or appears to be larger) than the instrument is capable of reading. This is caused by a saturated input amplifier or by the A/D converter.

*b. Inaccurate Readings.* Inaccurate readings are usually caused when the measurement circuitry is not linear.

*c. Constant Zero Reading.* A constant zero reading can be caused by either the input of the input amplifier or input to the A/D converter being shorted to ground. It can also be caused if the A/D converter has no runup (integrate input) period.

*d. Floating Reading.* A floating reading is when the HP 3421A internal voltmeter returns a certain reading (with no input applied) which does not change after an input is applied. This can be caused by the A/D converter, or if there is an open in the input circuitry.

*e. Noisy Readings.* Noisy readings can be caused by the input circuitry or the A/D converter.

**1-8-29. AC Volt Failures (Service Group B).** An ac volt failure can be overload, inaccurate, floating, or noisy readings. If an ac failure is encountered, check to make sure the dc volt function is operating properly (paragraph 1-8-28) before going to the ac service group. The reason for this is that the ac section uses all of the high range dc circuitry (plus the ac to dc converter), and it is easier to troubleshoot with a dc input. Thus, if there is an ac problem, but no dc problem, you should suspect the failure is with the ac to dc converter circuitry. If, however, a dc problem is also found, it is probably the cause of the ac failure as well. The following explanations are for ac volt failures.

*a. Overload.* An overload is caused when the reading is larger (or appears to be larger) than the instrument is capable of reading. This can be caused by a saturated ac to dc converter or the A/D converter.

*b. Inaccurate Readings.* Inaccurate readings are normally caused when the ac to dc converter has poor frequency response.

*c. Floating Reading.* A floating reading is when the HP 3421A internal voltmeter returns a certain reading (with no input applied) which does not change after an input is applied. This can be caused by an open circuit in the ac to dc converter or or the A/D converter.

*d. Noisy Reading.* Noisy readings can be caused by the input amplifier, or the ac to dc converter.

**1-8-30. Ohms Failures (Service Group C).** Typical ohms failures can be overload, inaccurate, floating, or noisy readings. Before going to the ohms service group, check to make sure the the dc volt function is operating properly (paragraph 1-8-28). This is because the two functions use much of the same circuitry. If a problem is found with the dc volts function, it will probably solve the ohms problem. If no problem is found with the dc function, you should suspect the ohms current source circuitry. The following explanations are for ohms failures.

*a. Overload.* An overload is caused when the reading is larger (or appears to be larger) than the instrument is capable of reading. This can be caused if the ohms current source is supplying too much current. However, this can also be caused by the input amplifier or the A/D converter. Therefore, make sure the dc volt function is operating properly (paragraph 1-8-28) if the ohms function fails.

*b. Inaccurate Readings.* Inaccurate readings can be caused by the ohms current source changing values under different loads, or if the measurement circuitry is not linear. Make sure the dc volt function is operating properly (paragraph 1-8-28) if this function fails.

*c. Constant Zero Readings.* A constant zero reading is usually caused when the ohms current source does not supply any current. It can also be caused when either the input to the input amplifier or the input to the A/D converter is shorted to ground. Make sure the dc volt function is operating properly (paragraph 1-8-28) if this function fails.

*d. Floating Reading.* A floating reading is when the HP 3421A internal voltmeter returns a certain reading (with no resistance being measured) which does not change when a resistance measurement is attempted. This can also be caused by the input circuitry or the A/D converter. Make sure the dc volt function is operating properly (paragraph 1-8-28) if this function fails.

*e. Noisy Reading.* A noisy reading is unstable and is most likely caused by a noisy ohms current source. It can, however, be caused by the input amplifier. Make sure the dc volt function is operating properly (paragraph 1-8-28) if this this failure is encountered.

**1-8-31. A/D Converter Failures (Service Group D).** A/D converter failures are normally caused by the A/D converter itself or the main controller (U508). An A/D converter failure might be detected by self test. The following explains the failures.

*a. Overload, Constant Zero, Floating, or Noisy Readings.* Any of these failures can be caused by the A/D converter or the input circuitry (input switching or input amplifier). A procedure to isolate the circuit failure is in both Service Group D and Service Group A. For a definition of the failures refer to paragraph 1-8-28.

*b. A/D Converter Failure.* This failure can be caused by the A/D converter or the main controller (U508). An A/D converter problem can cause constant zero readings, constant overload, and offset errors. An A/D converter failure will probably be detected during self test.

*c. Input Hybrid (U102) Failure.* Since the input hybrid receives its set-up information from the CPU (U508), this type of failure could be either the hybrid or the CPU. Symptoms of an A/D converter failure could be overload, constant zero, floating, or noisy readings.

**1-8-32. Control Logic Failures (Service Group E).** Control logic failures consist of turn-on, display, control ROM, CPU RAM, calibration RAM, and I/O failures. The following explanations are for these type of failures. Several of these are checked during self test.

*a. Turn-On Failure.* A turn-on failure is when the HP 3421A display and I/O (HP-IL or HP-IB) is dead (i.e., the instrument is completely inoperative). This can be caused by a bad CPU (U508) and associated circuitry, or power supply.

*b. Inoperative Display.* An inoperative display is when part or all of the display is inoperative. This problem can be caused by the display itself, CPU (U508), or CPU port expanders (U511, U512).

*c. Control ROM Failure.* A control ROM failure could exhibit a variety of symptoms because the CPU firmware is stored in this ROM. This firmware is what allows the instrument to perform its various functions, including power down and power up. Control ROM failures could include a stuck address or data bus bit, an enable line problem, or invalid data at some ROM address. A stuck address or data bus bit could be caused by other devices that share these lines (XRAM, CALRAM, HP-IL Chip), Address Latch, Port Expanders, or perhaps the CPU. Enable line problem could be caused by the ROM select circuitry, the ROM, or the CPU.

*d. XRAM Failure.* This type of failure will most likely be detected during self test, and could result in a variety of problems (a specific function problem, CPU lockup, inability to store the proper channel list, etc.).

*e. Calibration RAM (CMOS RAM) Failure.* This type of failure is most likely detected by the self test. CAL RAM failures cause erroneous readings to result, which may not be obvious. This is especially true if you are unaware of what the readings are supposed to be. Such Errors may be the result of an uncalibrated instrument or a defective Cal Ram Battery.

*f. I/O Failures (HP-IL or HP-IB).* This type of failure is most likely caused by the HP-IL I/O chip. This is true even if the HP-IB option is installed because the HP-IL chip is still used. If the HP-IB option is installed, the problem could also be the HP-IB option itself. Another possible cause of this type of failure could be the chassis common logic circuitry.

**1-8-33. Power Supply Troubleshooting (Service Group F).** This service group contains troubleshooting information for the power supplies, reference circuitry, and battery charger circuitry. If the battery charger circuitry fails, the HP 3421A will be unable to operate on its internal battery (i.e., with the ac power disconnected).

**1-8-34. Theory of Operation (Service Group G).** This service group provides a detailed theory of operation for the instrument.

**1-8-35. Mnemonics, Block Diagram, Component Locator, and Schematics (Service Group H).** This service group contains a mnemonic table, detailed block diagram, component locator, and schematics. Where applicable, voltages are shown on the block diagram and schematics for troubleshooting purposes. However, most waveforms (and some voltages) are dependent upon what function has been selected, and the characteristics of the input being applied. Where this is the case, the waveforms and/or voltages will be found in the service group associated with a particular functional area of the instrument, with an explanation of how they can be obtained.

## 1-8-36. TROUBLESHOOTING SETUP

1-8-37. Typically, the HP 3421A will have installed options. To troubleshoot the instrument, all options should be removed so the various test points and components can be accessed. The disassembly and reassembly procedures are given in the following paragraphs. The procedures assume that 10-channel Multiplexer/Actuator Assemblies occupy slots 0 and 1, a Digital I/O Assembly occupies slot 2, and that an HP-IB option is installed. This may or may not be how your instrument is configured. It should, however, be adequate examples for the disassembly and reassembly procedures.

### 1-8-38. Disassembly

1-8-39. To disassemble the instrument, do the following:

a. Make sure the HP 3421A is turned off and ac power cord is disconnected from the instrument. Also make sure all external sources of power have been removed from the option terminal blocks.

b. Turn the instrument upside down. This is preferably done on top of a protective mat to reduce the possibility of scratching or marring the instrument case. Refer to Figure 1-8-4 and loosen the six screws on the instrument bottom.

c. Hold the top cover in place and turn the instrument upright. Then remove the top cover.

d. Refer to Figure 1-8-5 and locate the battery fuse toward the right rear of the instrument. Remove it from its socket. Instead of removing the fuse, you can unplug the red wire from the battery. If this is done, make sure the wire is placed out of the way and away from the battery.

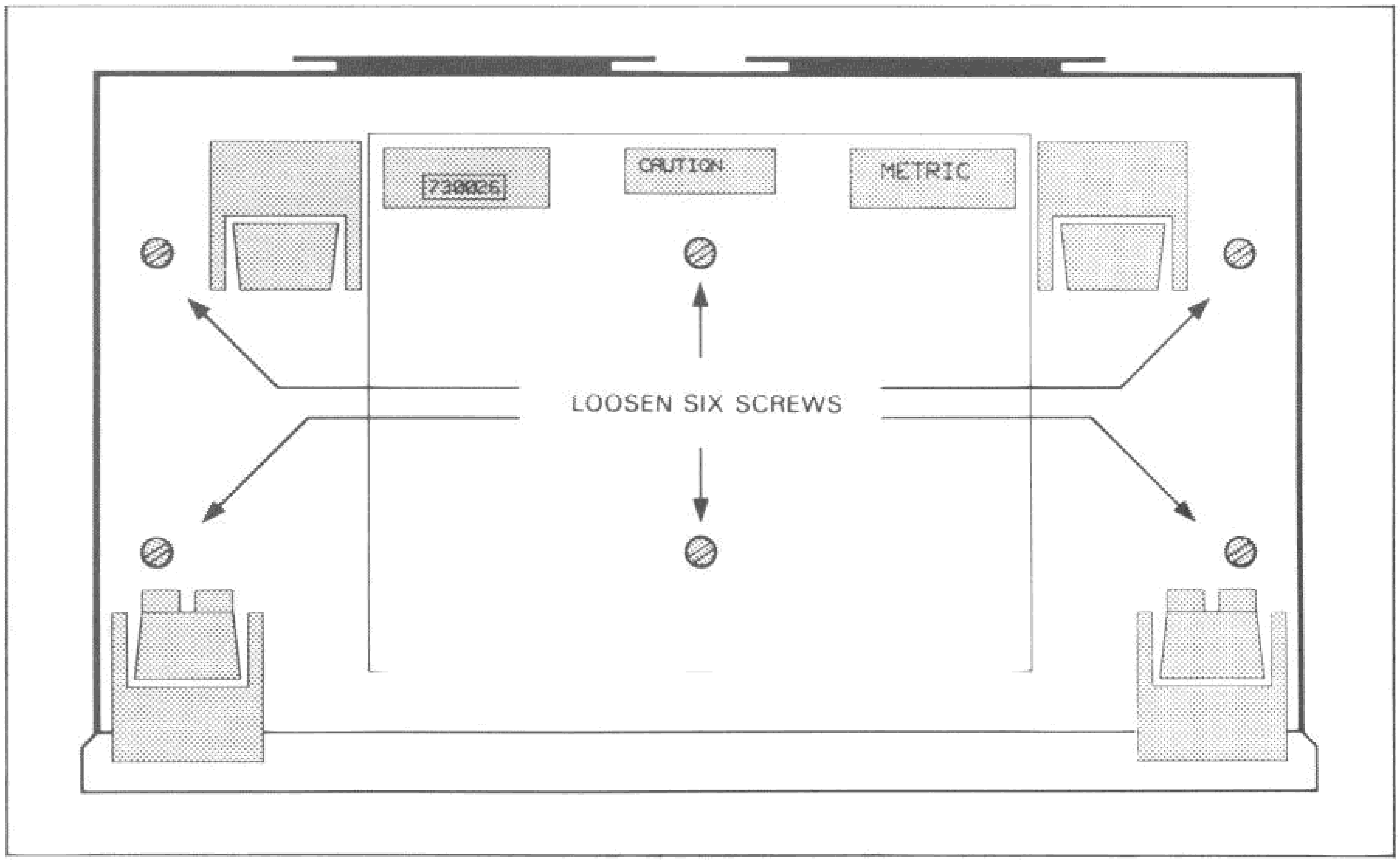



Figure 1-8-4. Loosen Bottom Screws

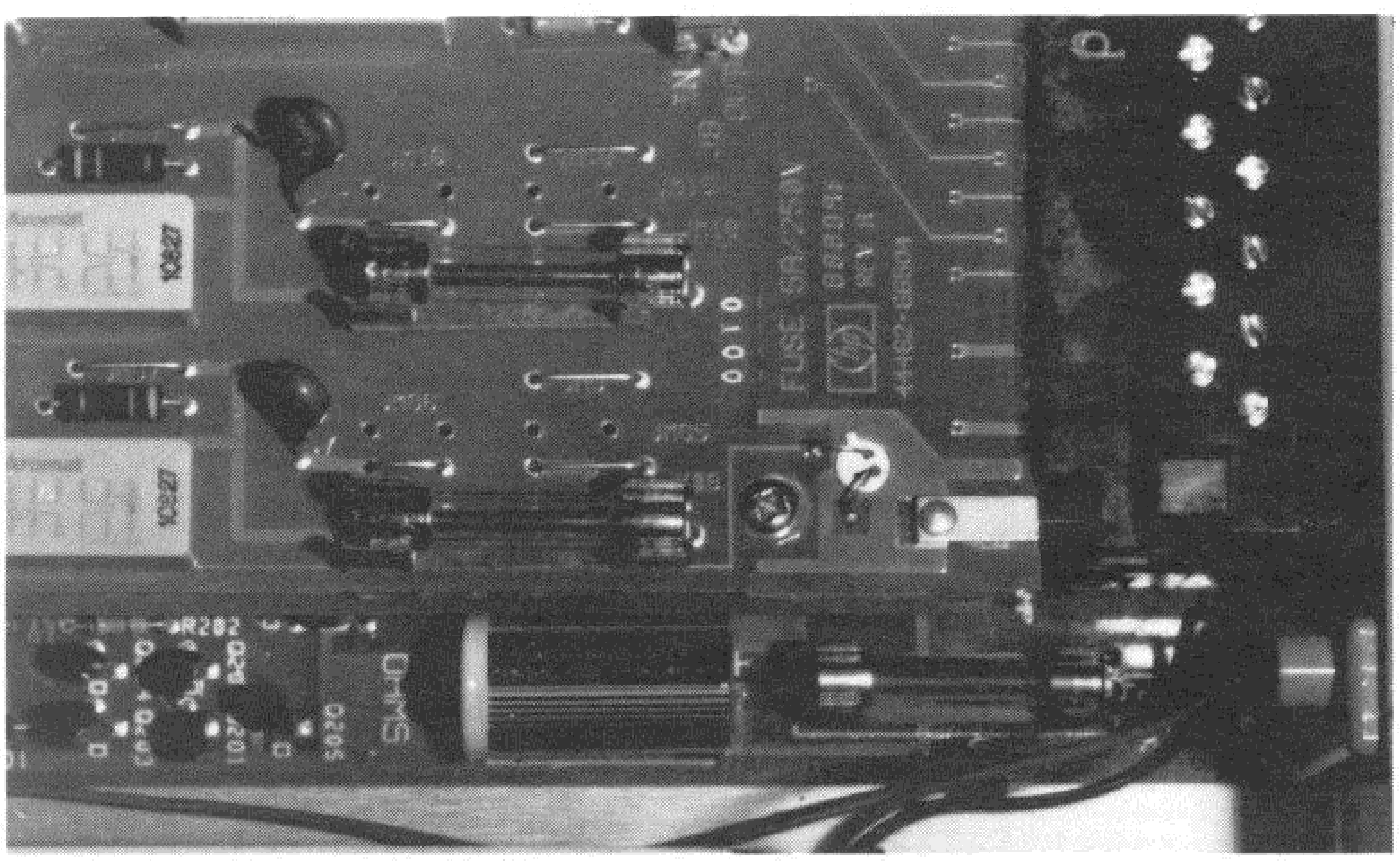


Figure 1-8-5. Remove Main Battery Fuse

**NOTE**

*When removing Multiplexer Assemblies, make sure they are re-installed in the slots from which they were removed. If this is not done, the instrument must be re-calibrated for each Multiplexer whose slot location is different than the slot in which it was calibrated.*

e. Remove the strain relief and grey "WARNING" safety cover from slot 1. Use the following procedure. If other options are also to be removed, use the same procedure to remove the appropriate strain reliefs and "WARNING" covers from the other options.

1. Refer to Figure 1-8-6 and remove the two screws holding the black strain relief bar.

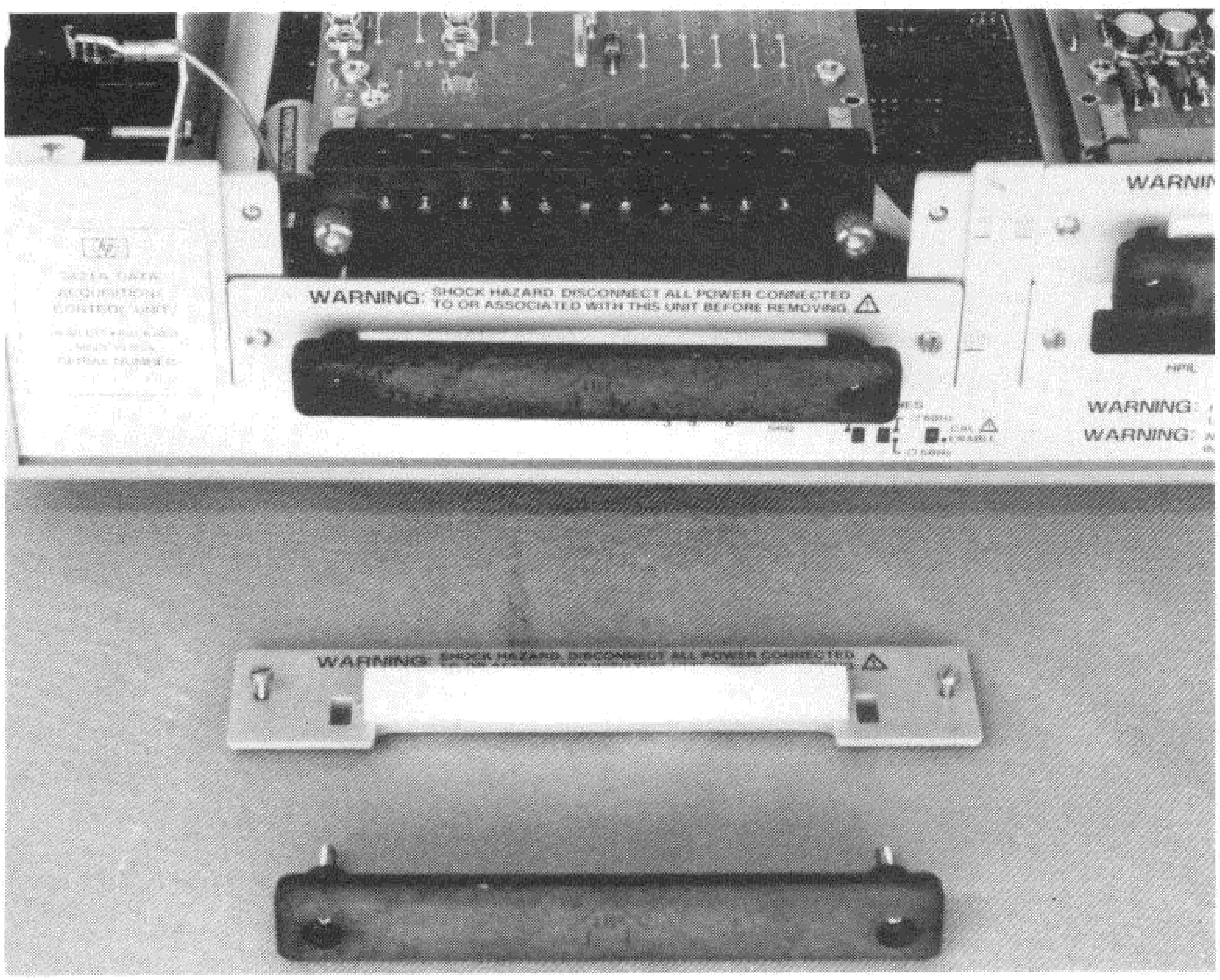



**Figure 1-8-6. Remove Strain Relief and Safety Cover from Slot 1**

2. Loosen the two captive screw that hold the grey "WARNING" safety cover.

3. Loosen the two screws holding the terminal block to the option circuit board and then remove the terminal block.

f. If an option is installed in slot 1, refer to Figure 1-8-7. Unplug the ribbon cable connector from the option in slot 1. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

g. Locate and remove the four screws holding the option in place.

h. Remove the option from slot 1. To prevent any recalibration of the option, tag the option as option 1 and make sure the same option board is placed back into the instrument into the same slot.

i. Refer to Figure 1-8-7 to unplug the ribbon cable connector from the option in slot 0. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

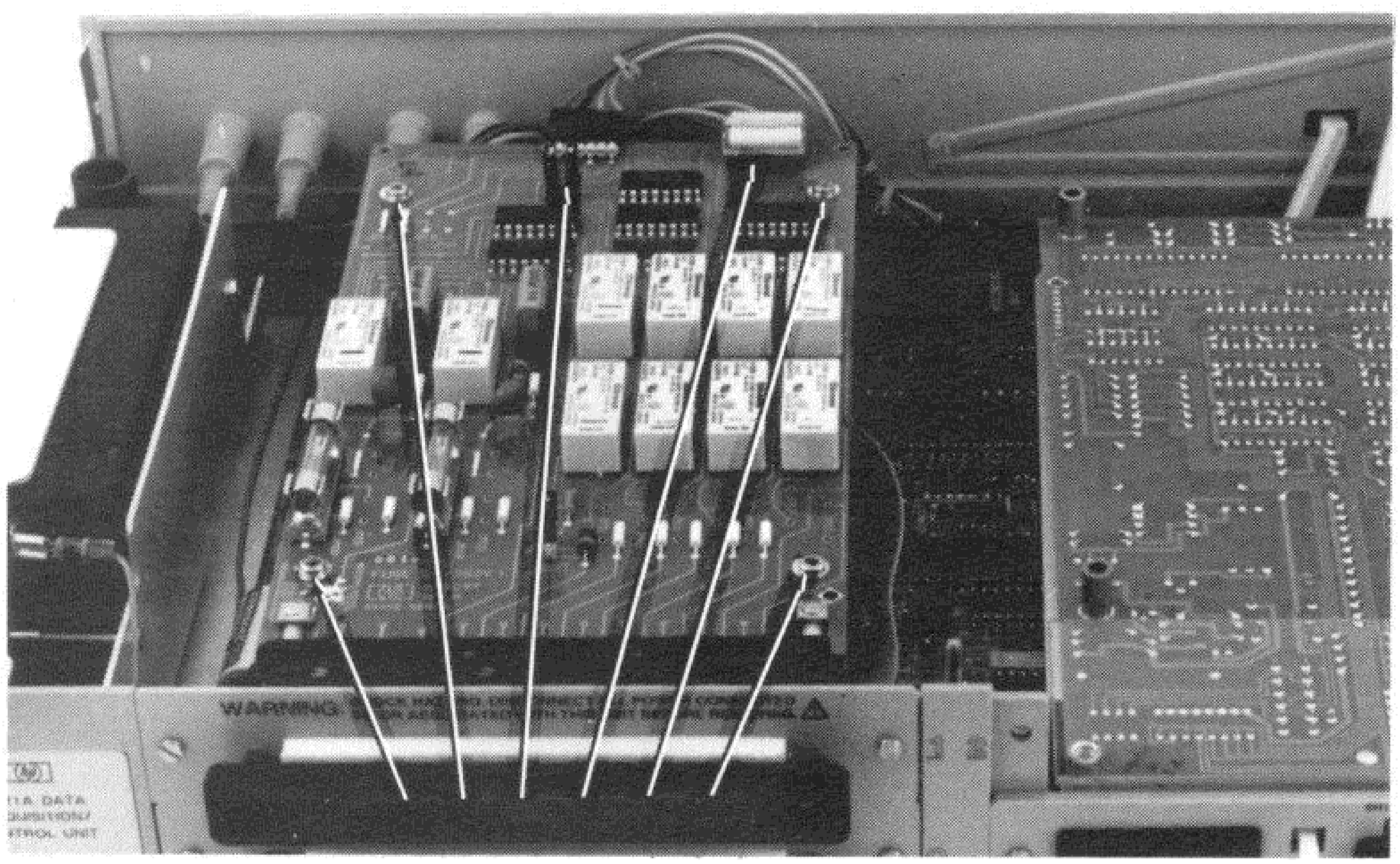


**Figure 1-8-7. Unplug Option Cable(s) and Remove Option Screws**

j. Using a 7/32" wrench, remove the four hex screws standoffs as shown in Figure 1-8-8.

k. Remove the option from slot 0. To prevent any recalibration of the option, tag the option as option 0 and make sure the same option board is placed back into the instrument into the same slot.

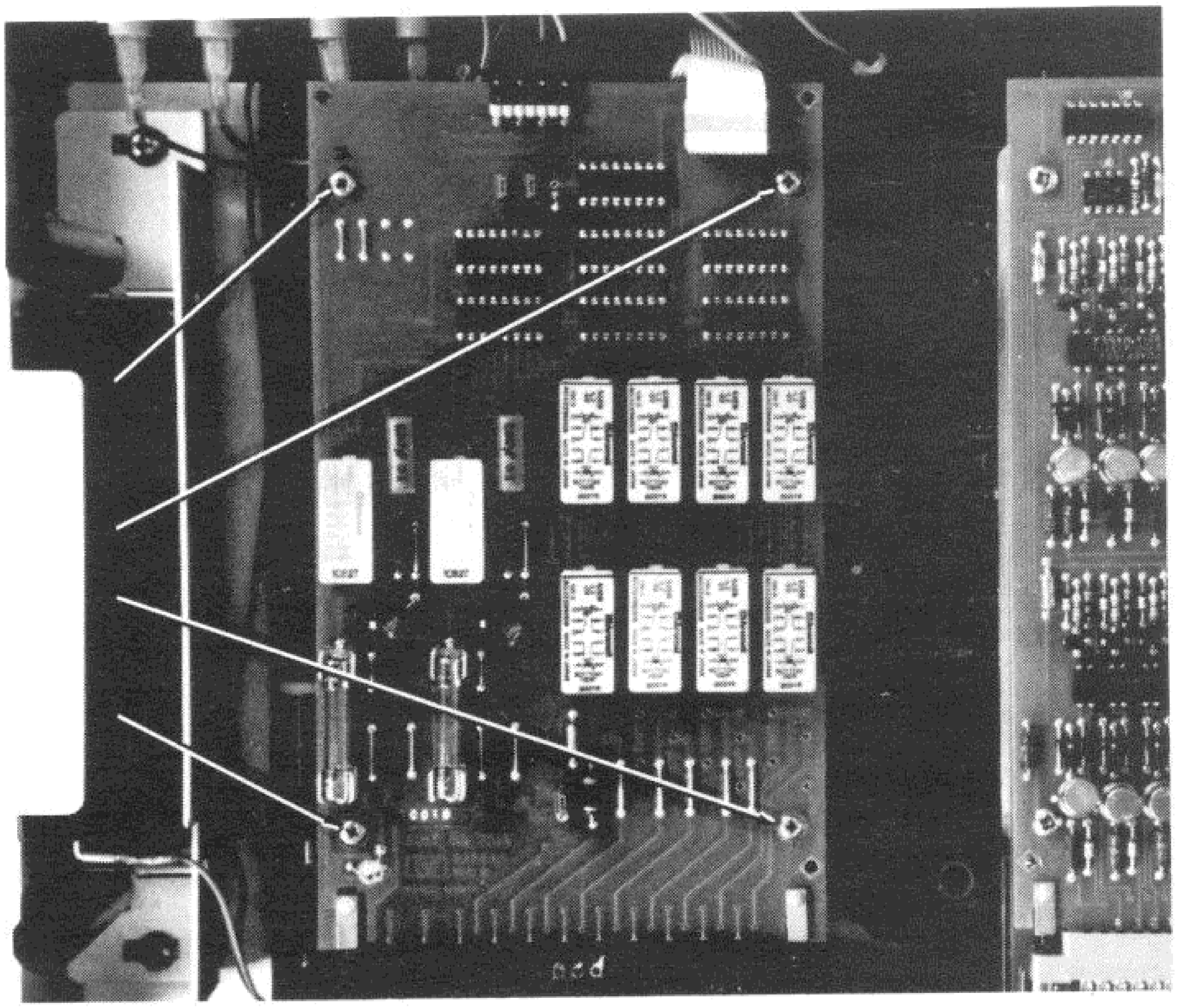


Figure 1-8-8. Removing Hex Screw Standoffs

1. Leave the bottom hex standoffs in place to secure the motherboard to the chassis. This ensures that the motherboard has a good ground, as shown in Figure 1-8-9.

**NOTE**

*The hex standoffs securing the motherboard to the chassis are shorter than the hex standoffs separating the slot 0 and slot 1 options.*

*Some of the first instruments manufactured may have round standoffs that are riveted to the motherboard instead of the screw-in hex standoffs. If the instrument has round standoffs, secure the motherboard to the chassis by using the four loose spacers that were used to separate the slot 0 and slot 1 options and the four long screws. These must be in place to make the proper ground connection for the motherboard.*

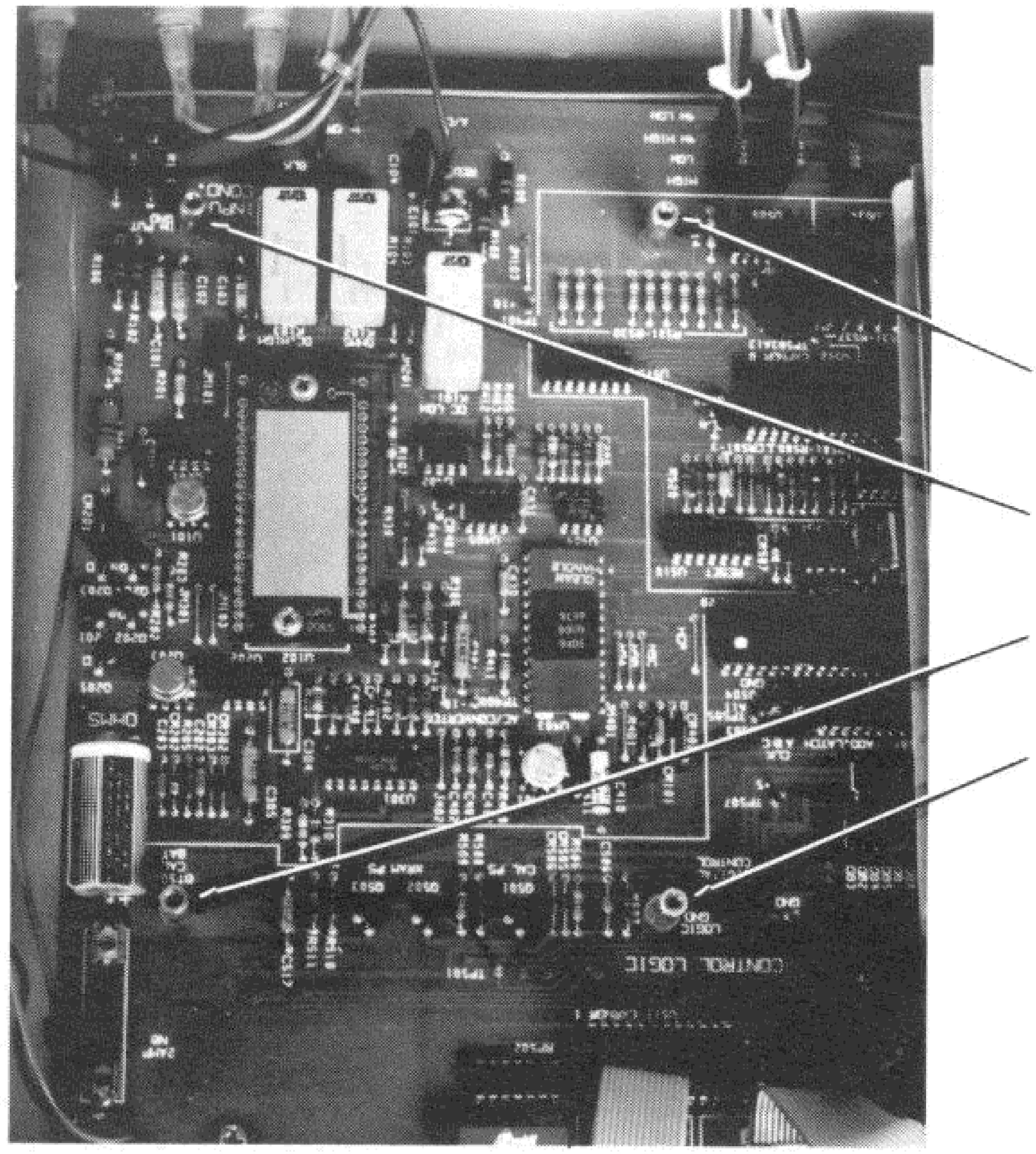


**Figure 1-8-9. Standoffs for Motherboard Ground**

m. Refer to Figure 1-8-7 and unplug the ribbon cable connector from the option in slot 2. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

n. Locate and remove the four screws holding the option in place.

o. Remove the option from slot 2. To prevent any recalibration of the option, tag the option as option 2 and make sure the same option board is placed back into the instrument into the same slot.

p. If the instrument is equipped with HP-IL, proceed with step r. If the HP-IB option is installed, do the following:

1. Remove the HP-IB rear panel as shown in Figure 1-8-10. It is not necessary to disconnect the HP-IB connector from the rear panel.

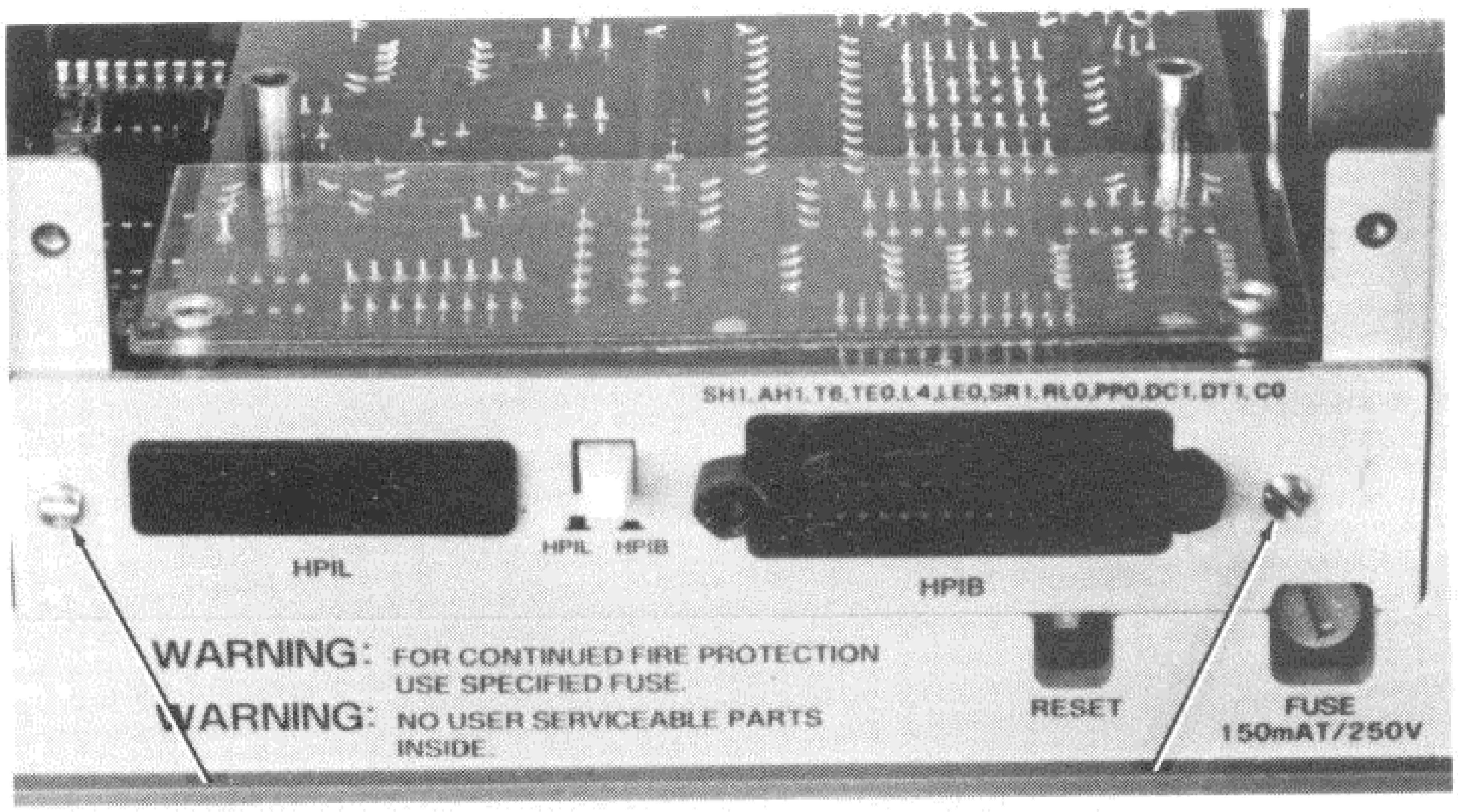



**Figure 1-8-10. Removing Rear Panel Screws from HP-IB Connector**

2. If you are going to use the HP-IB option as the computer interface for troubleshooting, lift the option up on its side so the bottom shield can be removed. Once the shield is removed, you are ready for troubleshooting. Since the HP-IB option will not be secured, make sure is does not touch or short other motherboard components during troubleshooting. If you want to use HP-IL as the computer interface, you can either place the HP-IB/HP-IL switch to HP-IL position or remove the HP-IB interface. To remove the HP-IB interface, perform steps 3 thru 8. Otherwise continue with step q.

3. Unscrew the black screws holding the HP-IB connector to the rear panel cover.

4. Unplug the green-white wire from the HP-IB option. Leave the other end of this wire plugged in the motherboard.

5. Unplug the connector with the red and black wires from the HP-IB option. Leave the other end of these wires connected to the motherboard.

6. Unplug the cable coming from the rear panel HP-IL connector.

7. Unplug the connector with the yellow and blue wires from the motherboard.

8. Plug the cable coming from the rear panel HP-IL connector onto the motherboard connector vacated in the previous step. Your instrument is now configured for HP-IL.

q. Remove the bottom shield from the instrument.

r. Replace the main battery fuse or reconnect the red wire to the battery.

s. To replace a component on the motherboard, remove the two screws securing the power transformer. Also remove the four screws securing the motherboard, and the four hex standoffs. Unplug the main battery and display cables. Lift out the front and rear panels. To remove the front panel, push the front panel switch all the way in, and then pull the front panel out and up.

### 1-8-40. Reassembly

1-8-41. The reassembly procedure assumes that the same options are installed that were removed in the disassembly procedure. It is important to reinstall a Multiplexer Assembly into the slot from which it was removed. If this is not done, the reference junction on the Multiplexer Assembly must be re-calibrated for temperature. The instrument will also require re-calibration if a Multiplexer Assembly is installed in a slot previously unoccupied.

1-8-42. It is permissible to alter the slot allocations for the options, keeping in mind that this may require an instrument re-calibration. However, it is recommended that Multiplexer Assemblies be used in slots 0 and 1 and the Digital Assembly in slot 2. These are the slot allocations used in the following reassembly procedure. The procedure may not reflect how your instrument is configured, but it should suffice as an example of how to reassemble the instrument.

1-8-43. To reassemble the instrument, do the following:

a. After the motherboard has been reinstalled, replace the rear panel. Leave the front panel off.

b. Set the bottom shield in place as shown in Figure 1-8-11. Now replace the front panel.

**NOTE**

*Figure 1-8-11 shows the shield used when the HP-IB option is installed. If the instrument does not have the HP-IB option, the shield is different than what is shown. The HP-IL shield extends over the rear panel HP-IL connector and has longer standoffs to make the option in slot 2 align properly.*

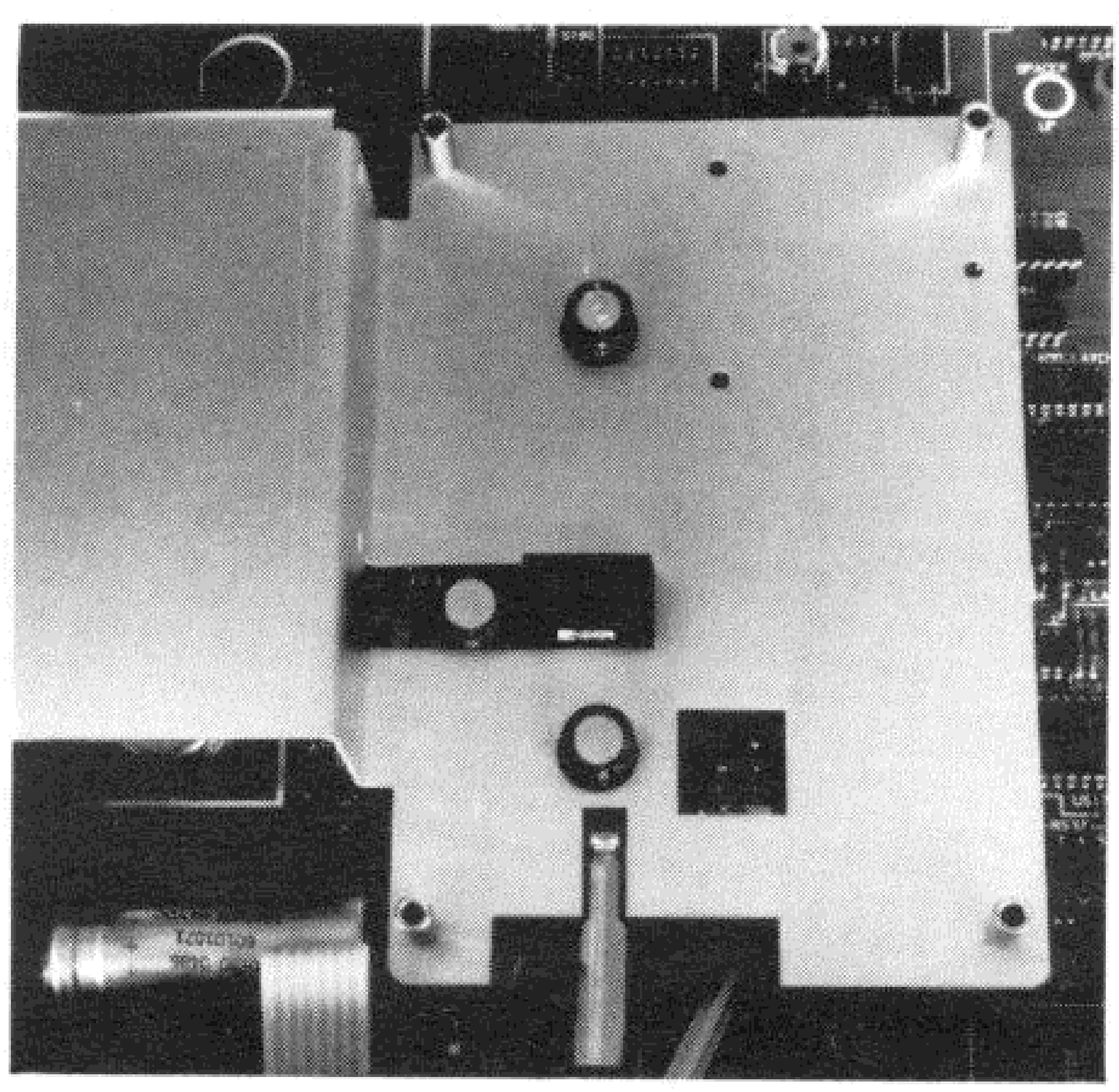


**Figure 1-8-11. Set Bottom Shield in Place**

c. Route the ribbon cable for the option that will occupy slot 2 around the shield standoffs, as shown in Figure 1-8-12. This cable should be plugged into J502 on the motherboard with the red stripe oriented to the right (pin 7 of the connector).

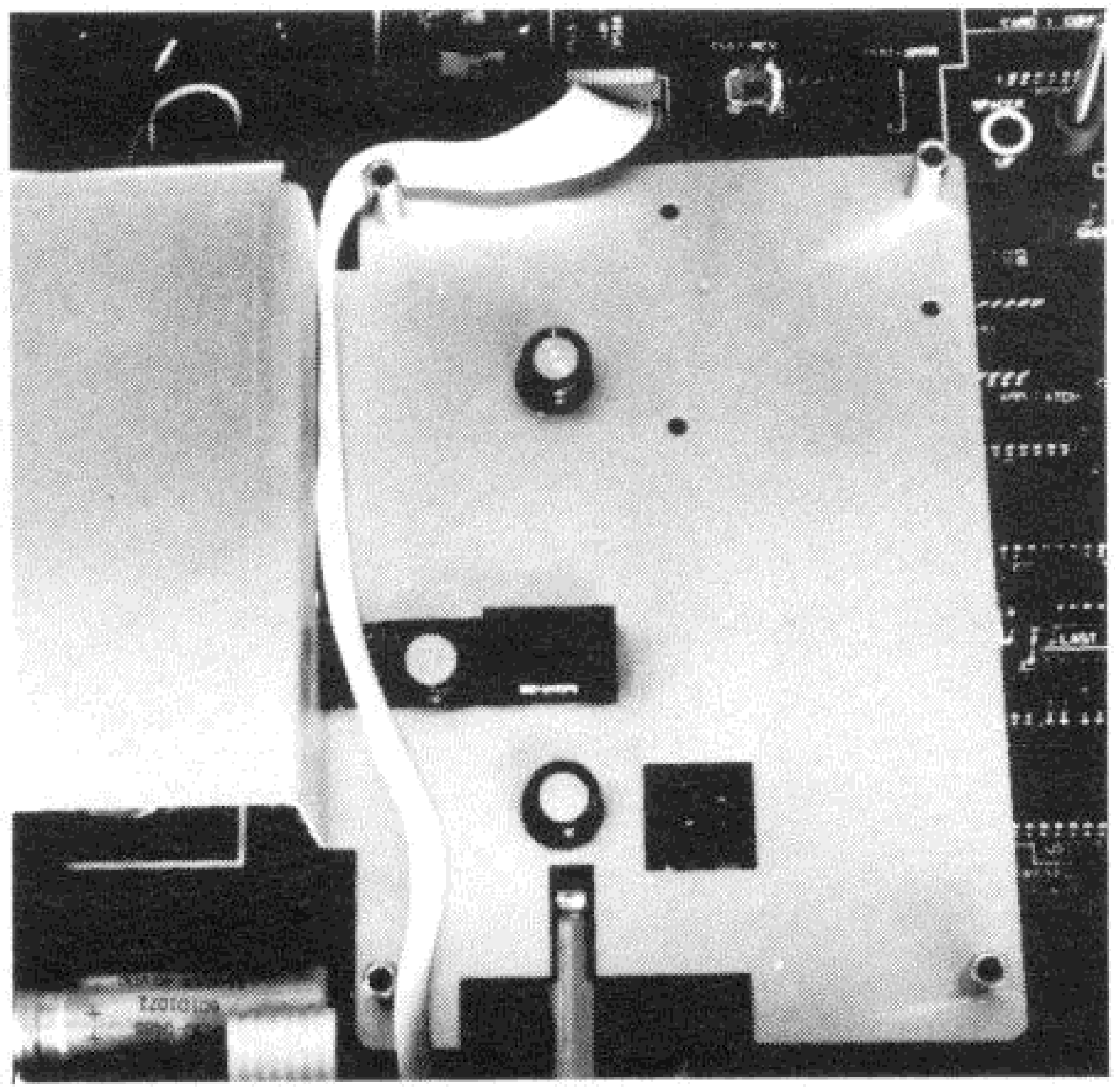


**Figure 1-8-12. Slot 2 Option Cable Routing**

d. If your instrument is *NOT* equipped with HP-IB, set the slot 2 option directly on the bottom shield with the component side up. Then put the four long screws in place. Do not tighten the screws at this time. Continue with step g.

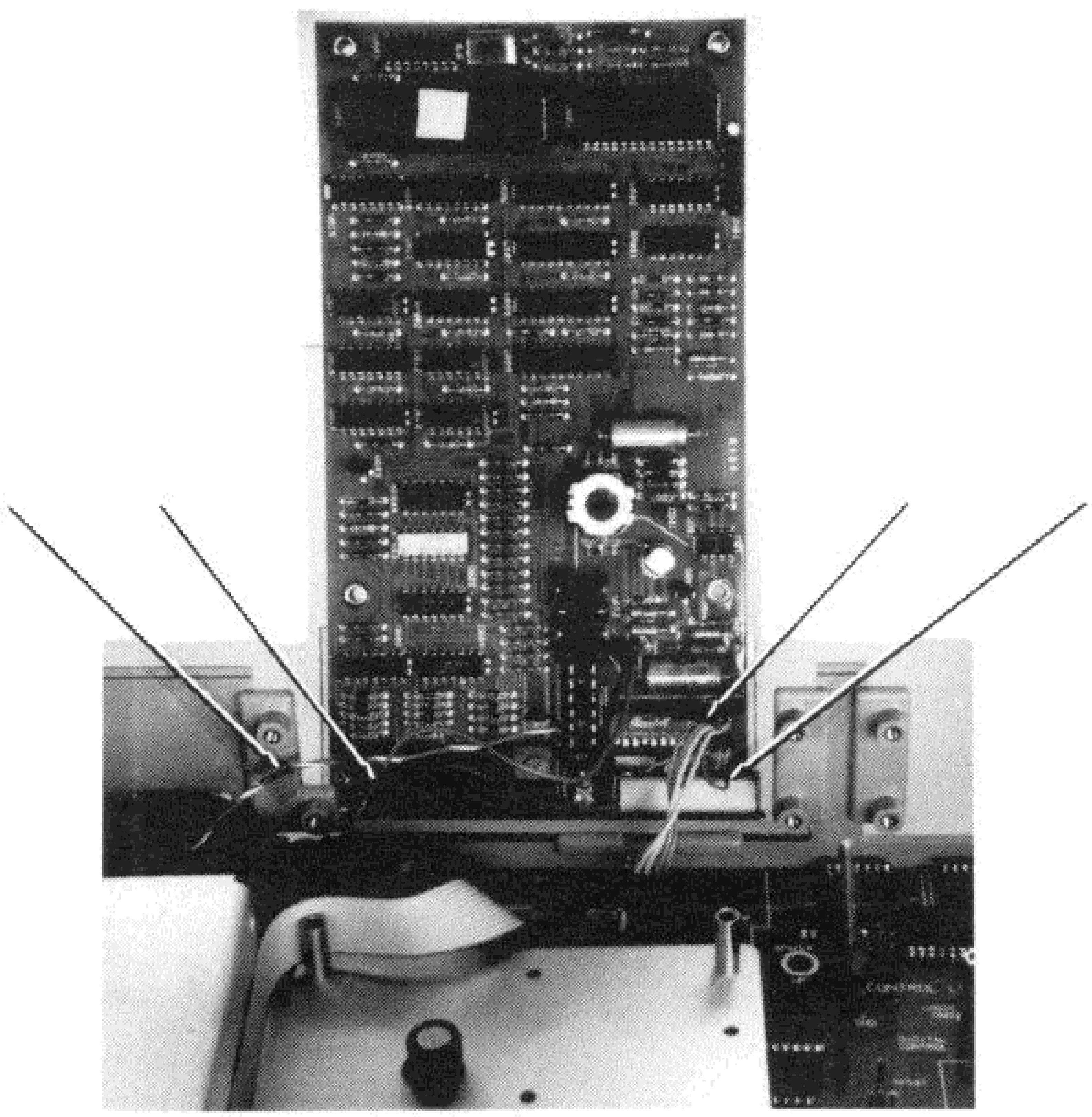


**Figure 1-8-13. Connect HP-IB Option Wires/Cables**

e. If your instrument is equipped with HP-IB, refer to Figure 1-8-13 and plug the various cables and wires between the HP-IB option and motherboard as follows:

**WARNING**

*For installation and operating safety, make sure the green-white wire is connected exactly as directed.*

Green-white wire between J802 on the HP-IB board and J702 on the HP 3421A motherboard (HP-IB ground). In early instruments, the wire was soldered to earth ground on the motherboard AC connector (J700).

Connect the 2-wire cable (red and black wires) between J803 on the HP-IB option board and J701 on the HP 3421A motherboard. The red wire is connected to "+" on the HP-IB board and toward the rear of the HP 3421A motherboard.

Connect the 4-wire cable (blue and yellow wires) between J804 on the HP-IB option board and J505 on the motherboard. Make sure the cable is connected to the HP-IB board as shown on the board (i.e., blue wire to BLU and yellow wire to YEL). Also make sure the yellow wire is connected to pin 1 of J505 and the blue wire to pin 4 of J505 on the motherboard.

f. Refer to Figure 1-8-14 and set the HP-IB and slot 2 options in place. The HP-IB option should be placed component side down and the slot 2 option component side up. Then put the four long screws in place. Do not tighten the screws at this time.

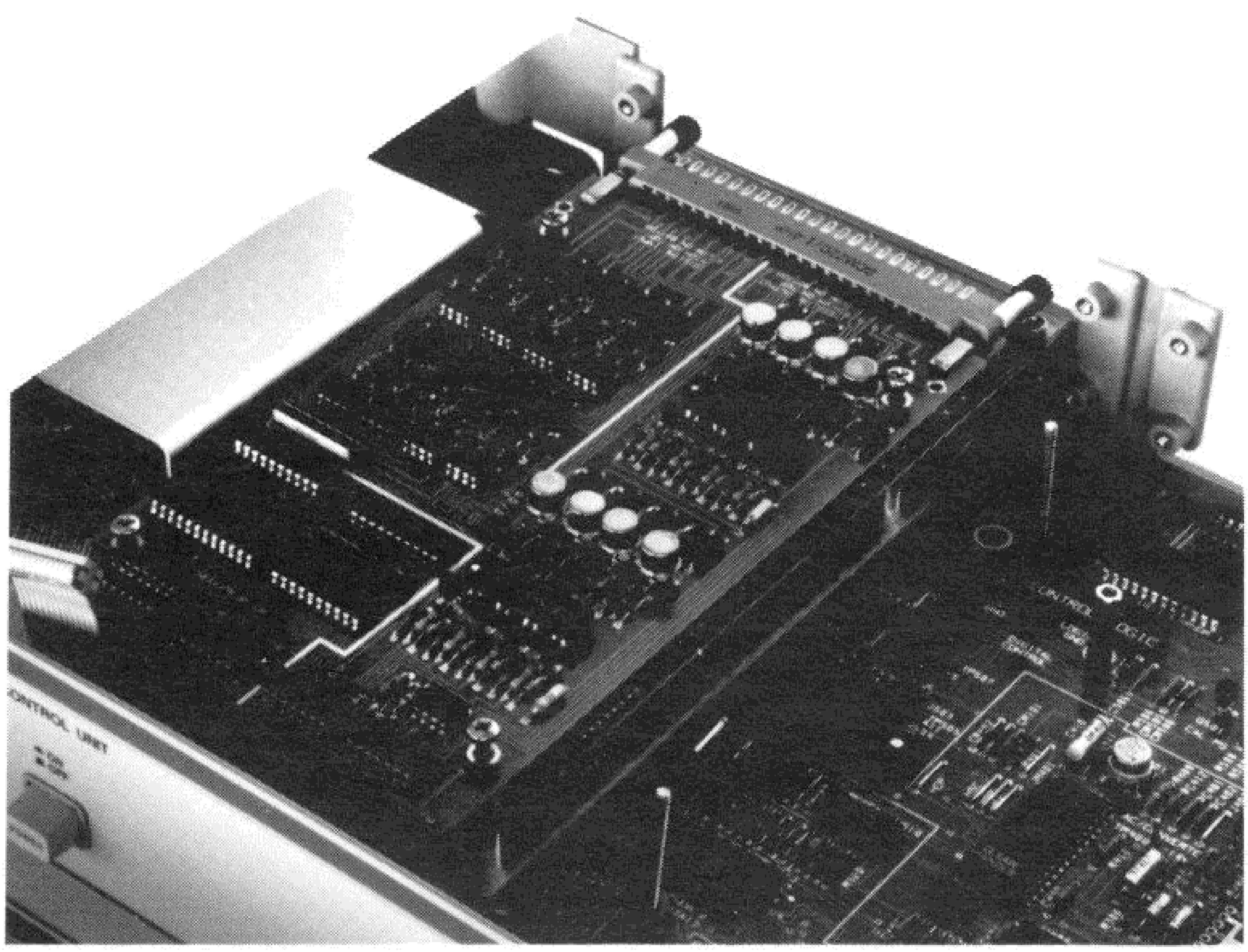


**Figure 1-8-14. Set HP-IB and Slot 2 Options in Place**

g. Plug the appropriate terminal block edge connector onto the slot 2 option.

h. Install the rear panel cover for the HP-IB or 12 VDC option (if applicable).

i. Install the rear panel cover (i.e., the grey "WARNING" cover) for the slot 2 option.

j. Secure the HP-IB connector (if applicable).

k. Align the slot 2 option so that the strain relief can be screwed into place. Screw the strain relief loosely into place.

l. Tighten the four screws that secure the slot 2 option.

m. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 2. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 2 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J100 with the wires oriented as noted on the motherboard.

n. Replace the four motherboard hex standoffs in the motherboard if they were removed. Do not overtighten these standoffs. Excessive torque (>11 in-lb) could break off the screw heads.

o. Route the ribbon cable for the slot 0 option as shown in Figure 1-8-15.

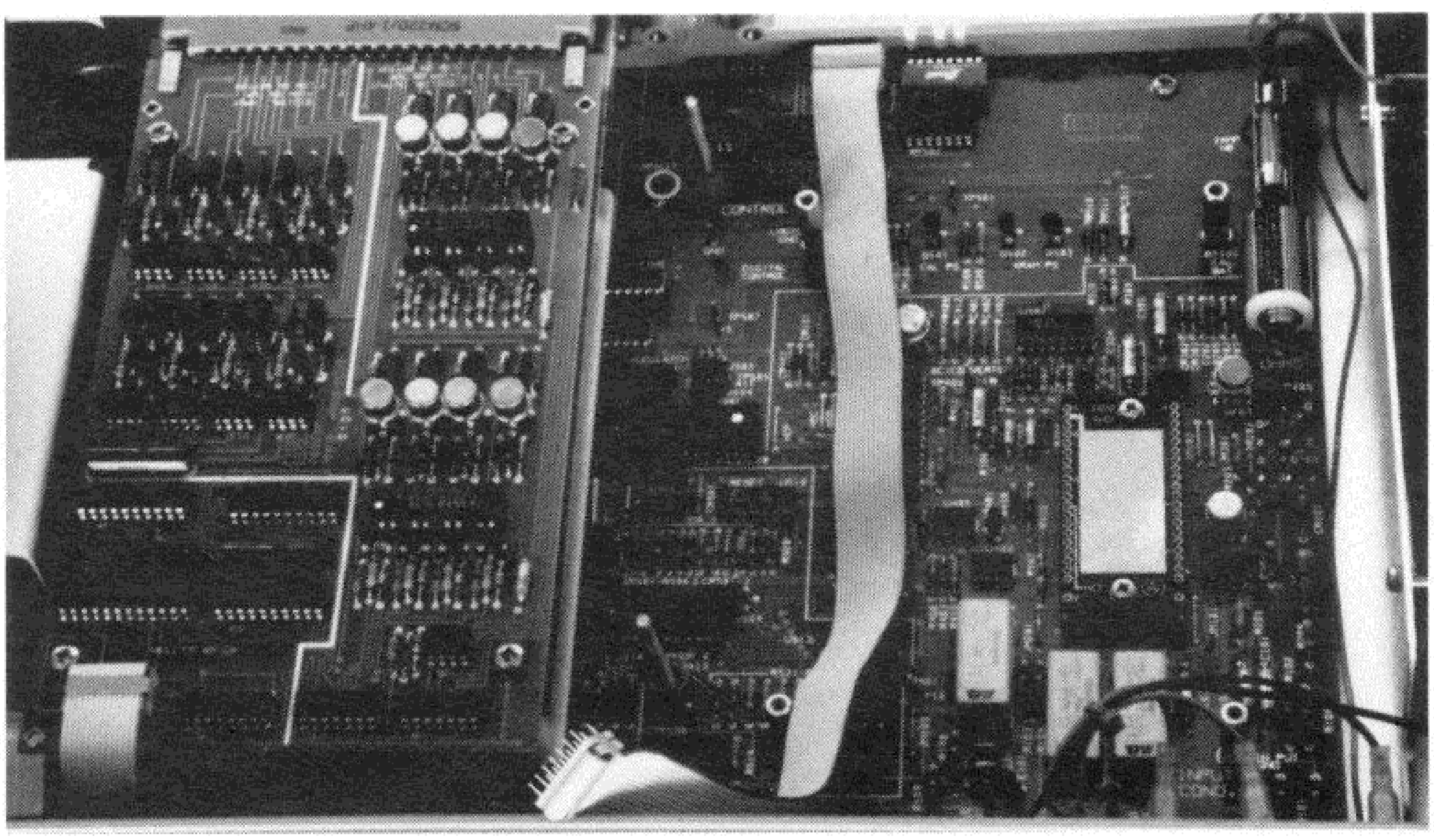


**Figure 1-8-15. Slot 0 Option Cable Routing**

p. Set the slot 0 option in place, component side up. Make sure the cable underneath is not pinched. Loosely screw the remaining four hex standoffs in place. Do not tighten the four standoffs at this time.

q. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 0. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 0 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J110 with the wires oriented as noted on the motherboard.

r. Plug the appropriate terminal block edge connector onto the slot 0 option.

s. Replace the rear panel grey "WARNING" safety cover for the slot 0 option.

t. Align the terminal block edge connector with the rear panel holes and loosely attach the strain relief for slot 0.

u. Tighten the hex standoffs to secure the slot 0 option. Do not overtighten the standoffs.

v. Route the ribbon cable from J501 on the motherboard across the slot 0 option as shown in Figure 1-8-16. Make sure the red stripe is oriented to the right (pin 7 of the motherboard connector).

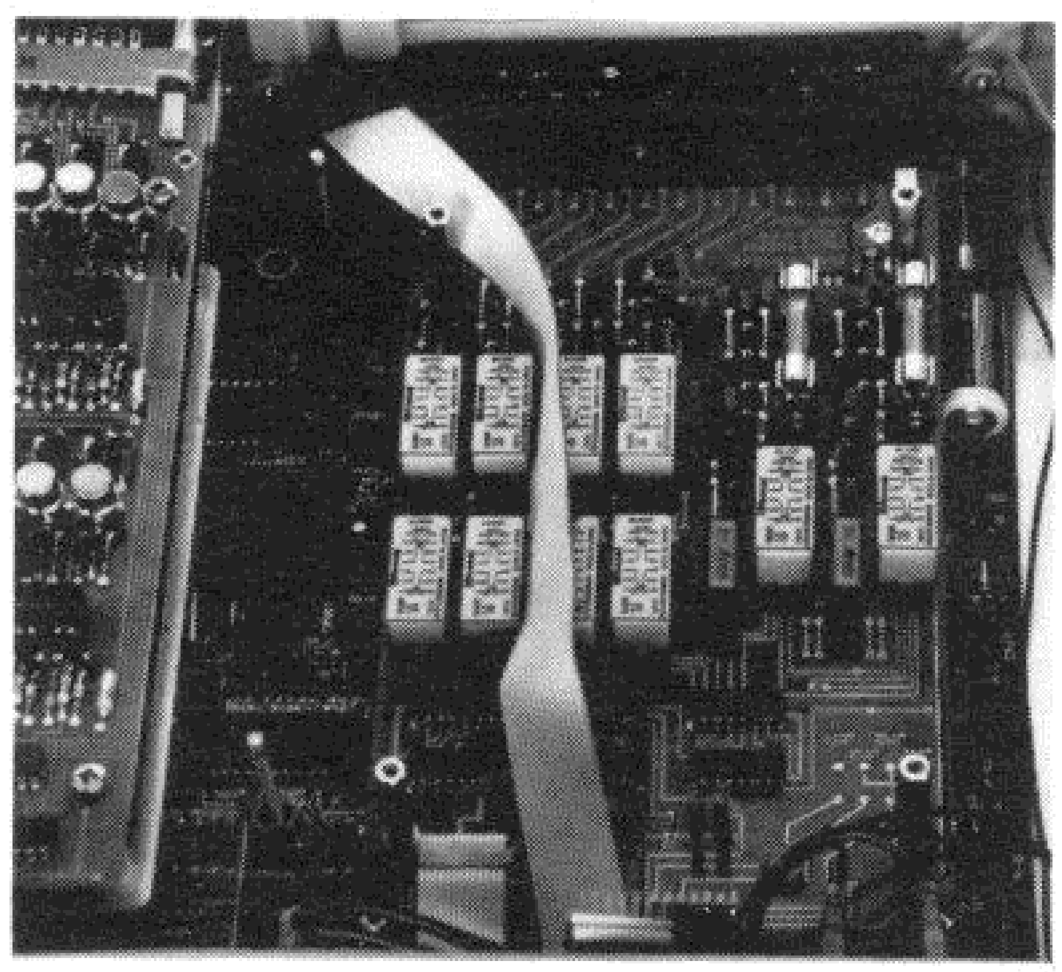


**Figure 1-8-16. Slot 1 Option Cable Routing**

w. Set the slot 1 option assembly in place. Make sure the ribbon cable underneath is not pinched. Then loosely screw four short screws in place. Do not tighten the four screws at this time.

x. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 1. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 1 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J120 with the wires oriented as noted on the motherboard.

y. Plug the appropriate terminal block edge connector onto the slot 1 option.

z. Replace the rear panel grey "WARNING" safety cover for the slot 1 option.

aa. Align the terminal block edge connector with the rear panel holes and loosely attach the strain relief for slot 1.

bb. Tighten the four screws to secure the slot 1 option. Do not overtighten the screws.

cc. Before replacing the top cover, first make sure the main battery fuse has been replaced. Then locate the six plastic spacers and place them on the cabinet screws as shown in Figure 1-8-17.

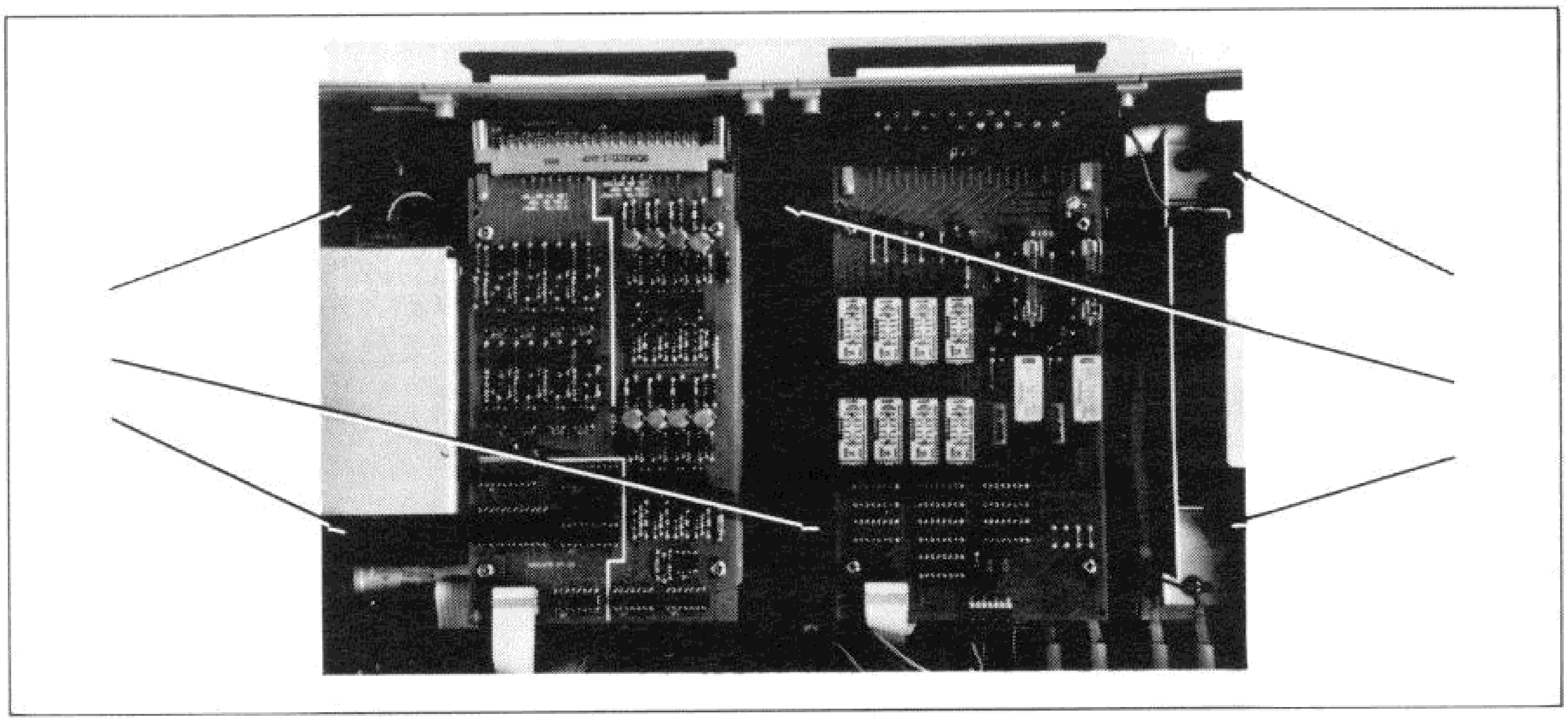


**Figure 1-8-17. Plastic Spacer Placement**

dd. Set the instrument flat on your work bench. Make sure the bale handles on the front feet are collapsed.

ee. Align the top cover and lower it in place. If the top cover does not go into place, make sure the front and rear grooves that guide it are properly aligned. If the grooves are aligned, one of the plastic spacers is probably out of alignment. To correct this, alternately move the top cover back and forth (left to right) until the spacers align properly.

ff. Once the top cover is in place, hold the two halves of the case together and turn the instrument upside down. Tighten the six bottom screws.

## 1-8-44. STRAIN RELIEF

1-8-45. The black strain relief bar presses wires and cables connected to the terminal block edge connector against a piece of foam on the grey "WARNING" safety cover. This provides strain relief for cables and wires connected to option assemblies.

1-8-46. Figure 1-8-18 shows several wires coming from the terminal block of the slot 2 option. When installing the bar, loosely attach one end first. Hold the other end down and away from the instrument. Leave a small loop in the wires to avoid stress on the terminal block connections. This reduces the possibility of breaking the wires at the strain relief. Then rotate the bar up and connect the other end.

1-8-47. For wires smaller than 22AWG, it is recommended that these wires be bundled together starting at no more than 4'' from the back of the instrument. This reduces the possibility of breaking the wires at the strain relief.

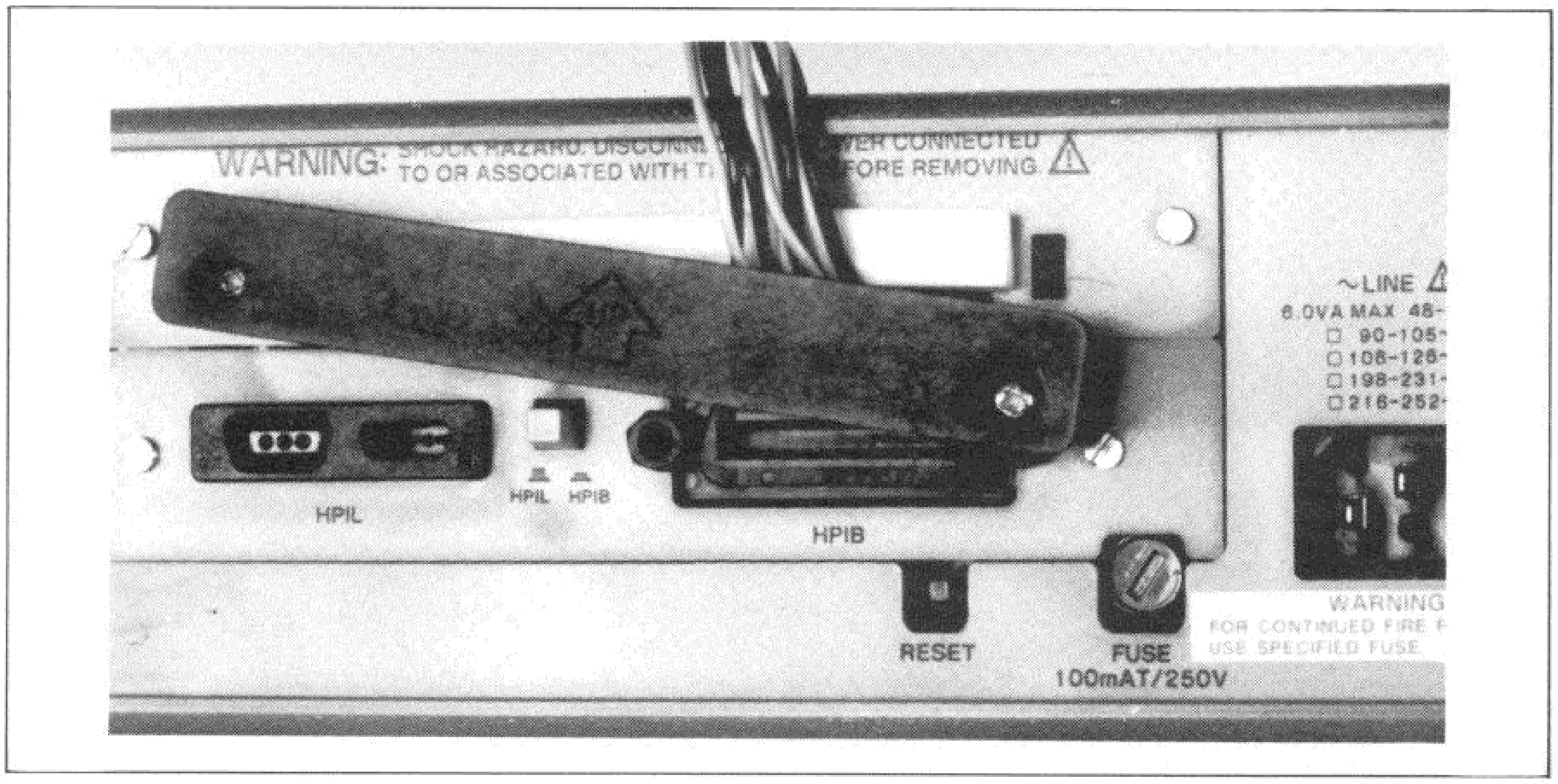



**Figure 1-8-18. Strain Relief for Slot 2**

# SERVICE GROUP A
# DC VOLTS TROUBLESHOOTING

### Service Group A Contents



**CAUTION**

*The instrument contains CMOS Integrated Circuits which are susceptible to failure from static discharge. It is especially important that grounded tools and wrist straps be used when handling or troubleshooting CMOS components.*

## 1-8-A-1. INTRODUCTION

1-8-A-2. This service group contains the dc volts troubleshooting procedures for the HP 3421A. The service group is symptoms oriented (i.e., what fails) with two different levels of troubleshooting. The first level will identify the general area of the HP 3421A that is failing; the second level has specific procedures for the area that fails. Unless otherwise specified, refer to Block Diagram and/or Schematic 1 when using these troubleshooting procedures.

1-8-A-3. Generally, troubleshooting requires a controller so the HP 3421A can be configured to the necessary function and/or range. In all troubleshooting procedures where a controller is required, programs are given for an HP-85 Computer. If your instrument is equipped with HP-IB, it is permissible to troubleshoot using HP-IB, keeping in mind that the HP-IB Option could be cumbersome because it is not securely mounted after the disassembly procedure is performed. Because of this, it is recommended that HP-IL be used if possible.

## 1-8-A-4. EQUIPMENT REQUIRED

1-8-A-5. The following equipment is required to perform the dc volts troubleshooting procedures:

HP-85 Computer equipped with HP-IL or HP-IB Interface (another controller can be used but the program lines may have to be modified for that controller)
dc power supply capable of outputting a stable +3Vdc voltage for the low range, and a stable +30Vdc voltage for the high range
Digital Voltmeter (-HP- 3456A recommended)

## 1-8-A-6. PRE-TROUBLESHOOTING CHECKS

1-8-A-7. Before troubleshooting the dc volts function (or any other function), check the following:

a. Make sure the power supply voltages are the correct value, stable, and not oscillating. The proper power supply voltages are listed in Table 1-8-A-1 (see Schematic 3).

**Table 1-8-A-1. Power Supply Voltages**

**NOTE**

*To check the voltages in this table, the front panel push button must be in the "ON" position and the HP 3421A must NOT be configured for a "Loop Power Down".*

| Power Supply | Check At | Range |
|---|---|---|
| +5V | TP +5V | +4.75V to +5.25V |
| −15V | TP −15V | −14.75V to −15.25V |
| +15V | TP +15V | +14.60V to +15.40V |
| VB | TP VB | +5.8V to +7.6V |
| VBATT | TP VBATT | +5.8V to +7.6V |

b. Make sure the reference supplies are correct and stable. To check these supplies, refer to Table 1-8-A-2 and Schematic 1.

**Table 1-8-A-2. Reference Supply Voltages**

| Reference Supply | Check At | Range |
|---|---|---|
| +10V | TP 401 | 9.5V to 10.5V |
| −10V | TP 400 | −9.5V to −10.5V |
| −10V Buffered | U404 pin 6 | −9.5V to −10.5V |

1-8-A-8. If any power supply or reference voltage is incorrect, refer to Service Group F before performing any troubleshooting procedure in this service group.

## 1-8-A-9. DC VOLTS TROUBLESHOOTING

1-8-A-10. Typical dc volt failures are overload, inaccurate, constant zero, floating, or noisy readings on either the low or high ranges. These failures were described at the beginning of Section VIII (see paragraph 1-8-29).

### 1-8-A-11. Overload, Floating, Constant Zero (with input applied), or Noisy Readings on All Ranges

1-8-A-12. If either of these failures are noted on all ranges, it is most likely the input circuitry (input hybrid or input amplifier) or the A/D converter that is at fault. It can, however, be caused by the counter circuitry or the ac to dc converter. Jumpers can help isolate the faulty circuitry. If you are experiencing one of these failures, perform the following procedure:

a. Perform the troubleshooting setup that is outlined at the beginning of Section VIII (see paragraph 1-8-35).

b. Connect the I/O cables from the controller to the HP 3421A.

c. Configure the HP 3421A for dc volts, 3V range, and autozero off by executing the following program. Note: the HP 3421A does not have a continuous trigger mode, and therefore the program must loop. Also, if autozero is not turned off, the measurement made in step e will be a square wave instead of a dc voltage.

```
10 OUTPUT 901 ; "F1R0Z0"
20 ENTER 901 ; A
30 DISP A
40 GOTO 20
50 END
```

d. Apply a stable +3Vdc to the Ω/V HI and Ω/V LO front panel terminals.

e. With a digital voltmeter (like the HP 3456A), measure the voltage at the output of the input amplifier (U101 pin 6). The voltage should be about +10Vdc, depending upon how close your input is to 3V (e.g., 3V input X 3.33 gain of input amp = 9.99V). If the voltage at U101 pin 6 is a stable +10Vdc, the A/D converter is at fault, in which case you should go to Service Group D for troubleshooting. If the voltage is anything other than +10V (overload, constant zero, floating, or noisy), proceed with step f.

f. Unsolder and lift one end of JM103 and then measure the voltage at U101 pin 6 again. If the voltage is now good (i.e., a stable +10V), the A/D converter is at fault, in which case you should go to Service Group D for troubleshooting. If the voltage is still wrong, proceed with step g.

g. Unsolder and lift one end of JM101 and measure the voltage at U101 pin 6 again. If the voltage is now good (i.e., a stable +10V), the counter circuitry is at fault, in which case you should go to Service Group E for troubleshooting. If the voltage is still wrong, proceed with step h.

h. Unsolder and lift one end of JM301 and measure the voltage at U101 pin 6 again. If the voltage is now good (i.e., a stable +10V), the ac to dc converter circuitry is at fault, in which case you should go to Service Group B for troubleshooting. If the voltage is still wrong, either the input switching or input amplifier is at fault, in which case you should go to paragraph 1-8-A-24 for troubleshooting. However, before referring to paragraph 1-8-A-24, replace JM301, JM101, and JM103.

### 1-8-A-13. Constant Zero Readings (with no input applied) on All Ranges

1-8-A-14. The 30V and 300V ranges will normally have constant zero readings with no input applied because of the 100 kΩ resistor on the HI line (inside U102) that connects to ground. The .3V and 3V ranges, however, will normally float when no input is applied. If you are experiencing constant zero readings on both the high and low ranges with no input applied, make sure K103 is not stuck in a set state. When the .3V and 3V ranges are selected, K103 should be reset. If K103 goes to a set state when the .3V and 3V ranges are selected, U102 may be defective.

### 1-8-A-15. Overload, Floating, Constant Zero, or Noisy Readings (with input applied) on Some Ranges

1-8-A-16. The input hybrid (U102) and the input relays (K101 and K103) select the different paths by which the input signal is routed to the input amplifier (U101). The hybrid also selects the input amplifier gain characteristics via internal switching circuitry. Because of this, a defective relay or U102 can make certain ranges fail. These failures are explained in the following paragraphs.

**1-8-A-17. Overload.** An overload condition will occur if the input amplifier feedback circuitry is open. The feedback circuitry is in U102, which means that U102 is probably defective.

**1-8-A-18. Constant Zero Readings.** Constant zero readings are most likely caused by U102.

**1-8-A-19. Floating Readings.** A floating reading usually indicates that the path to the input amplifier is open. If you are experiencing floating readings with an input applied, do the following:

a. If the .3V and 3V ranges are defective, perform the following steps:

1. Short the input and output of K101 together as shown in Figure 1-8-A-1.

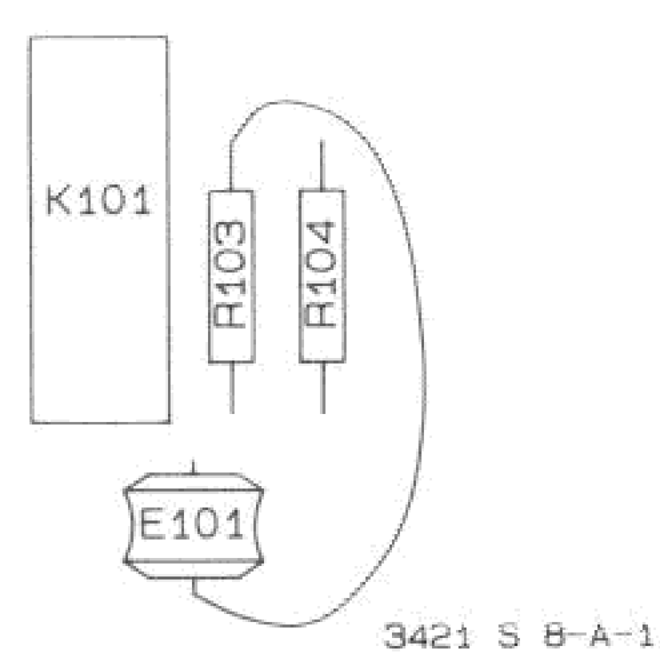



**Figure 1-8-A-1. Shorting K101 Input to Output**

2. If the .3V and 3V ranges are now good, make sure K101 is going to the set state when the .3V or 3V ranges are selected. Since K101 is a latching type relay, the only time the set coil has 5V across it is when the relay goes from a reset to set state. To check whether or not K101 is going to the set state, first execute "R1" (30V range) and then monitor U102 pin 27 on an oscilloscope while executing "R0" (3V range). U102 pin 27 should make a momentary high-to-low transition, and then return high again. Note: if the HP 3421A is configured for the 3V range (R0), you will not see transitions occurring at U102 pin 27 when subsequent R0 commands are executed. You must first configure the 30V or 300V range and then monitor the line when the 3V range is configured. The program lines required to first select the 30V range, and then the 3V range are as follows:

```
OUTPUT 901 ; "F1R1"
OUTPUT 901 ; "R0"
```

b. If the 30V and 300V ranges are defective, perform the following steps:

1. Short the input and output of K103 together as shown in Figure 1-8-A-2.

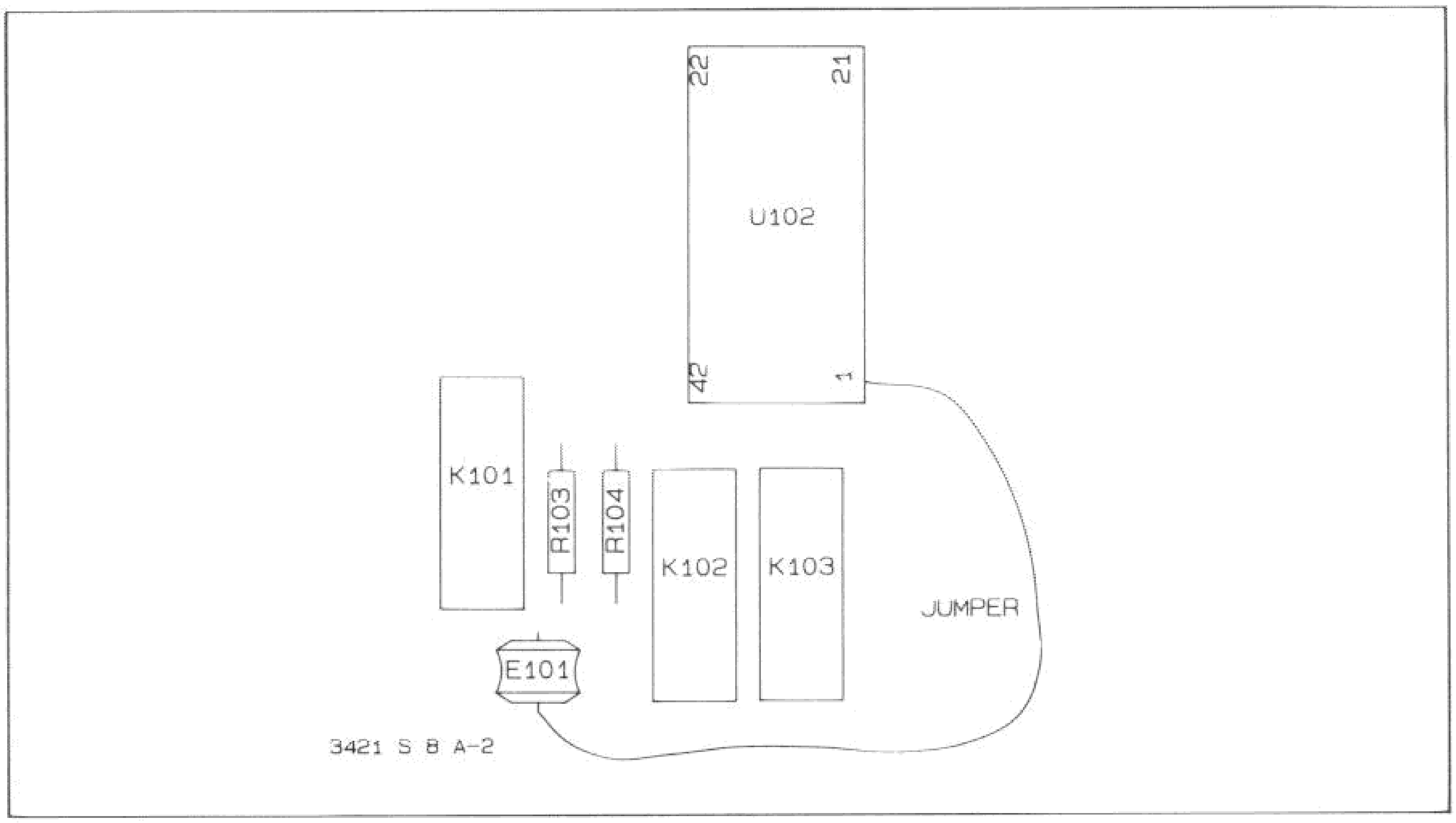



**Figure 1-8-A-2. Shorting K103 Input to Output**

2. If the 30V and 300V ranges are now good, make sure K103 is going to the set state when these ranges are selected. Since K103 is a latching type relay, the only time the K103 set coil has 5V across it is when the relay goes from a reset to set state. To check whether or not K103 is going to the set state, first execute "R0" (3V range) and then monitor U102 pin 29 on an oscilloscope while executing "R1" (30V range). U102 pin 29 should make a momentary high-to-low transition, and then return high again. Note: if the HP 3421A is configured for the 30V range (R1), you will not see transitions occurring at U102 pin 29 when subsequent R1 commands are executed. You must first configure the .3V or 3V range and then monitor the line as the 30V range is configured. The program lines required to first select the 30V range, and then the 3V range are as follows:

```
OUTPUT 901 ; "F1R1"
OUTPUT 901 ; "R0"
```

3. If you replace K103 and the ranges still fail, U102 is probably defective.

**1-8-A-20. Noise.** Noise can be caused by a FET switch internal to the input hybrid (U102), or the input amplifier (U101). Replace U101 first. If noise still exists, then replace U102.

### 1-8-A-21. Inaccurate Readings on All Ranges

1-8-A-22. Inaccurate readings usually occur at some voltage other than a positive full scale voltage. That is, the error in the reading occurs for all voltages except for positive full scale voltage, which will be proper. The reason for this is that when the HP 3421A is calibrated, the calibration RAM stores the calibration constants for zero and full scale (or ⅓ scale).

1-8-A-23. If you are experiencing inaccurate readings, the first thing to do is calibrate the instrument. The calibration procedure is explained in Section IV. Once the instrument has been calibrated, again check for inaccurate readings. If they are still occurring, they will probably occur at some voltage other than a positive full scale voltage, since you will have calibrated the instrument for full scale. For inaccurate readings, suspect the input amplifier (U101), input hybrid (U102), or possibly the calibration RAM (U502). However, if the calibration RAM is bad, the instrument will probably fail that segment of self test.

## 1-8-A-24. INPUT CIRCUITRY TROUBLESHOOTING

1-8-A-25. This circuitry consists of the input switching (K101, K103), input hybrid (U102), and input amplifier (U101). Input circuitry failures are described in the following paragraphs.

### 1-8-A-26. Overload Readings on All Ranges

1-8-A-27. An overload usually means that the output of the input amplifier (U101) is too high. This can be caused by an excessive input to the amplifier, an open in the amplifier feedback loop, or a defective amplifier. For overload readings, do the following:

a. Set the HP 3421A to dc volts, 3V range, and turn autozero off by executing the following program line:

```
OUTPUT 901 ; "F1R0Z0"
```

b. Short the HP 3421A Ω/V HI and Ω/V LO front panel terminals together.

c. With a high impedance digital voltmeter (like the HP 3456A), measure for zero volts dc (± 1mV) at U101 pin 3 (or U102 pin 10). If U101 pin 3 is out of tolerance, the input hybrid (U102) is defective. If U101 pin 3 is OK, proceed with step d.

d. If U101 pin 3 is good, connect pins 2 and 6 of U101 together. Then measure the voltage at U101 pin 6, which should be zero volts (± 3 mV). If the reading at U101 pin 6 is within tolerance, the amplifier feedback circuit is defective. Replace U102. If the reading is out of tolerance, the input amplifier is defective. Replace U101.

### 1-8-A-28. Constant Zero Readings on All Ranges

1-8-A-29. Constant zero readings are usually caused by the input signal path being shorted to ground. If you are experiencing this failure, make sure pins 1, 13, and 10 of U102, and pin 6 of U101 are not shorted to ground. If no shorts to ground are noted, do the following:

a. Set the HP 3421A to dc volts, 3V range, and turn autozero off by executing the following commands:

```
OUTPUT 901 ; "F1R0Z0"
```

b. Using an external power supply, apply +3V to U101 pin 3 through a 1 kΩ resistor, and connect the negative lead of the power supply to circuit ground.

c. Using a high impedance digital voltmeter (like the HP 3456A), make sure the voltage at the end of the resistor connected to pin 3 of U101 is +3V. If the voltage is low, U102 is probably defective. Replace U102 and then repeat the procedure. If, after replacing U102, the voltage is still low, replace U101.

d. If the voltage at U101 pin 3 is +3V, measure U101 pin 6 for approximately 10V (3V X 3.33 amplifier gain). If it is incorrect, the input amplifier is defective. Replace U101.

e. If the voltage at U101 pin 6 is correct (~ 10V), suspect the A/D converter (A/D hybrid (U403) or integrator (U401).

### 1-8-A-30. Floating Readings on All Ranges

1-8-A-31. Floating readings are usually caused by an open in the input signal path before the input amplifier. Such a failure may not be intuitively obvious, especially if an input is known to change from one reading to the next. A good way to find out if this type of problem exists is to input a known steady voltage and then take several readings. If they vary more than a couple of counts, then the reading is floating. To isolate this type of problem, do the following:

a. Set the HP 3421A to dc volts, 3V range, and autozero off by running the following program:

```
10 OUTPUT 901 ; "F1R0Z0"
20 ENTER 901 ; A
30 DISP A
40 GOTO 20
50 END
```

b. Apply a stable +3V to the HP 3421A Ω/V HI and Ω/V LO front panel terminals.

c. If the reading being input to the controller is now a steady +3V reading, make sure the external connections were correct when the floating reading was noted. If the reading is still floating, proceed with step d.

d. Using a high impedance digital voltmeter (like the HP 3456A), check U101 pin 6 for +10V (3V x 3.33). If it is correct, and you know the external connections were correct when the floating reading was observed, suspect a problem with the A/D converter (A/D hybrid (U403) or integrator (U401)). If the voltage at U101 pin 6 is still wrong, proceed with step e.

e. Remove the power supply from the front panel terminals. Use the positive lead of the power supply and apply a stable +3V to U101 pin 3 and connect the low lead of the power supply to circuit ground.

f. While running the program, check U101 pin 6 for +10V (3V x 3.33). If the voltage at U101 pin 6 is +10V, U102 is probably defective. If the voltage at U101 pin 6 is not +10V, U101 is probably defective, although the feedback loop for U101 (inside U102) could be causing the problem.

### 1-8-A-32. Noisy Readings on All Ranges

1-8-A-33. Noisy readings are most likely caused by the input hybrid (U102) or the input amplifier (U101). For noisy readings, do the following:

a. Set the HP 3421A to dc volts, 3V range, and autozero off by executing the following program lines:

```
OUTPUT 901 ; "F1R0Z0"
```

b. Using an external power supply, apply a stable +3V to the Ω/V HI and Ω/V LO front panel terminals.

c. Using a high impedance digital voltmeter (like the HP 3456A), check the voltage at U101 pin 6 for a stable +10V (3V x 3.33). If U101 pin 6 is good with autozero off, the input hybrid (U102) is defective. If U101 pin 6 is noisy, continue with step d.

d. Connect pin 2 and pin 6 of U101 to each other. This reduces the amplifier gain to unity (X1) by removing the feedback loop through U102.

e. With the feedback loop removed, measure for a stable +3V at U101 pin 3 (or U102 pin 10). If the voltage is noisy, there is probably a noisy component inside U102. If the voltage is stable, proceed with step f.

f. Measure the voltage at U101 pin 6. If it is noisy, replace U101. If it is stable, there is probably a noisy component in the feedback loop inside U102. Replace U102.

# SERVICE GROUP B
# AC VOLTS TROUBLESHOOTING

### Service Group B Contents



**CAUTION**

*The instrument contains CMOS integrated circuits which are susceptible to failures from static discharge. It is especially important that grounded tools and wrist straps be used when handling or troubleshooting these components.*

### 1-8-B-1. INTRODUCTION

1-8-B-2. This service group contains the ac volts troubleshooting procedures for the HP 3421A. Before troubleshooting an ac volt failure, make sure the dc volt function is operating properly (see Service Group A). The dc volt function must be operating properly before the ac volt function can operate properly. The reason for this is that both functions use much of the same circuitry.

### 1-8-B-3. EQUIPMENT REQUIRED

1-8-B-4. The troubleshooting procedures in this service group require the following test equipment.

HP-85 Computer equipped with HP-IL or HP-IB Interface
(another controller can be used but the program lines
may have to be modified for that controller)
Oscilloscope
AC Signal Source (capable of an 8.2V p-p, 1 kHz output).

### 1-8-B-5. AC VOLTS TROUBLESHOOTING

1-8-B-6. The ac volt function uses the same relay (K103) for both ac ranges (3V and 30V). An ac volt failure can be overload, inaccurate, floating, or noisy readings. The failures were explained at the beginning of Section VIII (see paragraph 1-8-28). The following paragraphs have the troubleshooting procedures for these failures. Unless specified otherwise, refer to Schematic 1 for the troubleshooting procedures.

### 1-8-B-7. Overload, Floating, or Noisy Readings

1-8-B-8. Assuming the dc volts function is operating properly, overload readings can be caused by a saturated stage in the ac to dc converter. Floating readings can be caused by an open circuit in the ac to dc converter. Noisy readings can be caused by any stage of the ac to dc converter, including a defective filter capacitor.

1-8-B-9. Since both ac volt ranges only use the K103 relay, first make sure that K103 is going to a set state when the ac volt function is selected. Also, since K103 is a latching type relay, the set coil will not have 5V across it all the time, only as it changes from a reset to set state. To check K103 perform the following procedure.

a. Execute the following program. Do not input an ac voltage at this time.

```
10 OUTPUT 901 ; "F1R0"
20 OUTPUT 901 ; "F2R1"
30 GOTO 10
40 END
```

b. When the above program is running, the HP 3421A is alternately configured between dc volts, 3V Range, and ac volts, 30V Range.

c. Use an oscilloscope and monitor U102 pin 29. This line should be make a high-to-low transition, followed by the line going high again. The high-to-low transition should occur about once per second. You may also observe a positive overshoot of about 6V, which is normal. If U102 pin 29 is OK, replace K103. If U102 is not OK, replace U102.

1-8-B-10. In the remaining troubleshooting procedures, a 1 kHz ac signal with an amplitude of 2.9V RMS (~ 8.2V p-p) will be input and then traced through the instrument. The waveforms shown, therefore, will be different that what you can expect if you input a signal that is different in frequency or amplitude, although they may be very similar. Also, if you are experiencing an ac failure at a particular frequency, it is suggested that your input correspond to the frequency that is causing the problem. The waveforms shown in the following procedure should suffice as examples, regardless of the frequency. To trace an ac signal through the instrument, perform the following procedure.

a. Set the HP 3421A to ac volts, 3V Range by executing the following program line:

```
OUTPUT 901 ; "F2R0"
```

b. Apply a 1 kHZ signal with an amplitude of 8.2 V p-p (2.9V RMS) to the HP 3421A Ω/V HI and Ω/V LO front panel terminals. The actual amplitude of the signal is not important, but should be less than 3V RMS, since we are using the 3V Range. If the amplitude is greater than 3V RMS and it is input to the controller while the instrument is configured for the 3V range, the HP 3421A will return an overload reading. This shows up as "999990000" (when displayed on the HP-85).

c. Set the oscilloscope to 2V/Div with a .5 ms sweep time and check for the waveform at E101 as shown in Figure 1-8-B-1. This check ensures that the ac input is getting to the input of the ac relay (K103).

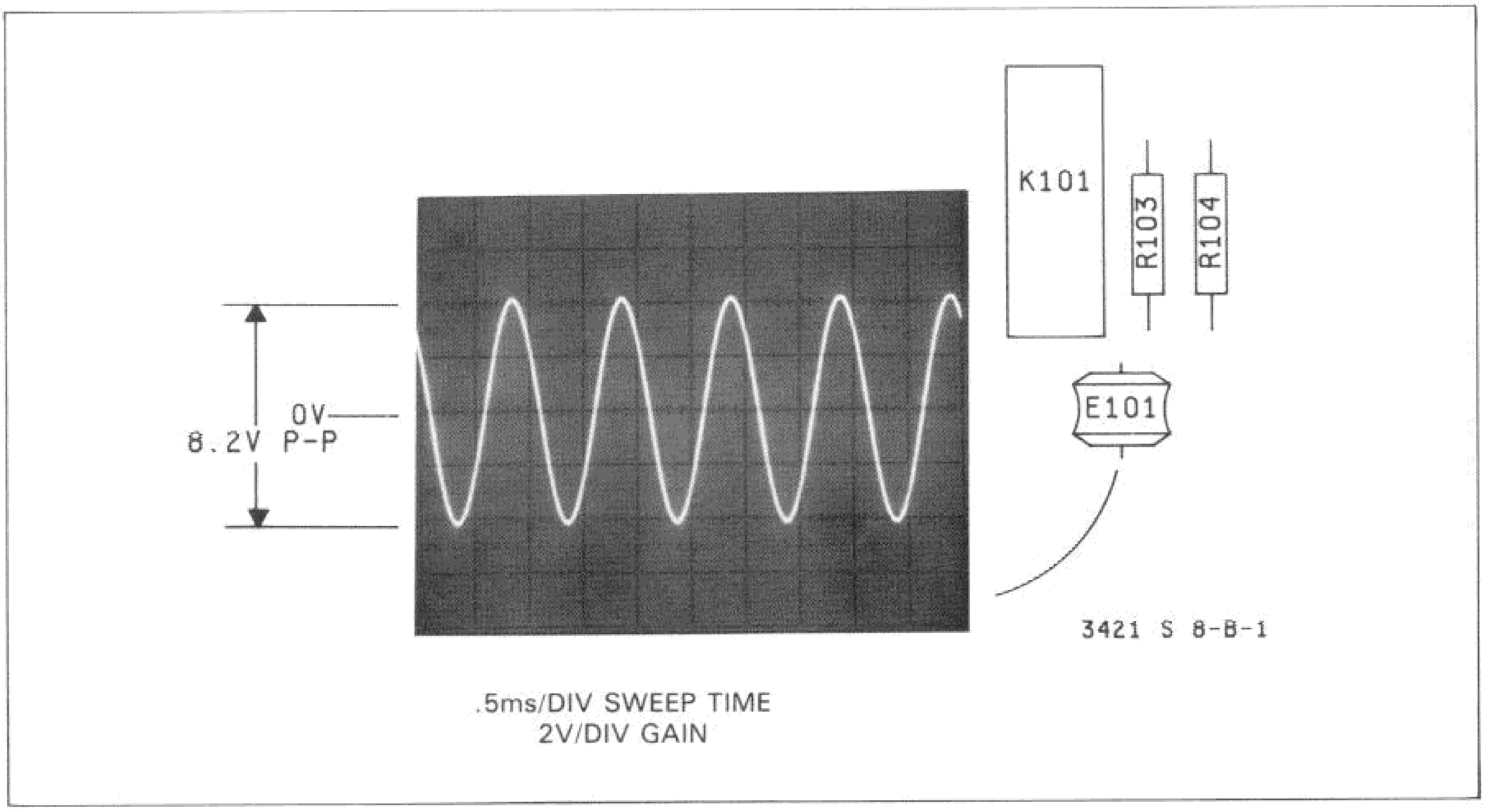



**Figure 1-8-B-1. AC Input Waveform at E101**

d. Check U102 pin 1 for the same waveform as in step c. If the input signal does not appear at U102 pin 1, then K103 either did not go to a set state or it is defective. Make sure the instrument is configured for ac volts, 3V range, before replacing the relay. Also, make sure the relay goes to the set state when the configuration commands are executed. The procedure to do this was explained at the beginning of this service group. If the waveform is correct, proceed with step e.

e. Check U101 pin 6 for the waveform shown in Figure 1-8-B-2. If it is incorrect, and the dc volts function is OK, suspect a problem with the ac input path inside U102. If U101 pin 6 is correct, proceed with step f.

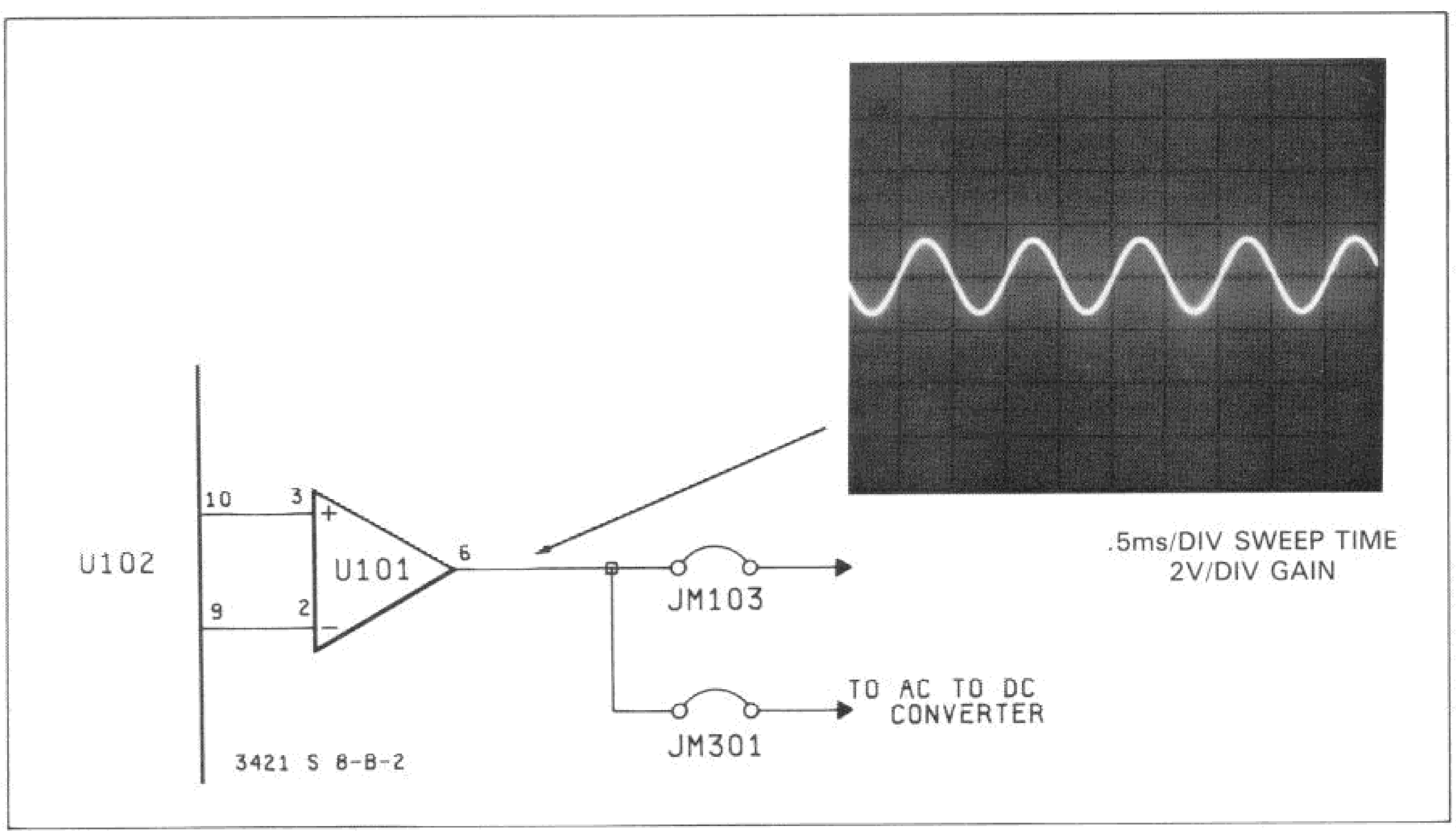



**Figure 1-8-B-2. U101 Pin 6 Waveform With AC Input**

f. Change the oscilloscope to .5V/div, and then check the anode of CR301 for the waveform shown in Figure 1-8-B-3. If it is incorrect, troubleshoot U301B and associated circuitry. If it is correct, proceed with step g.

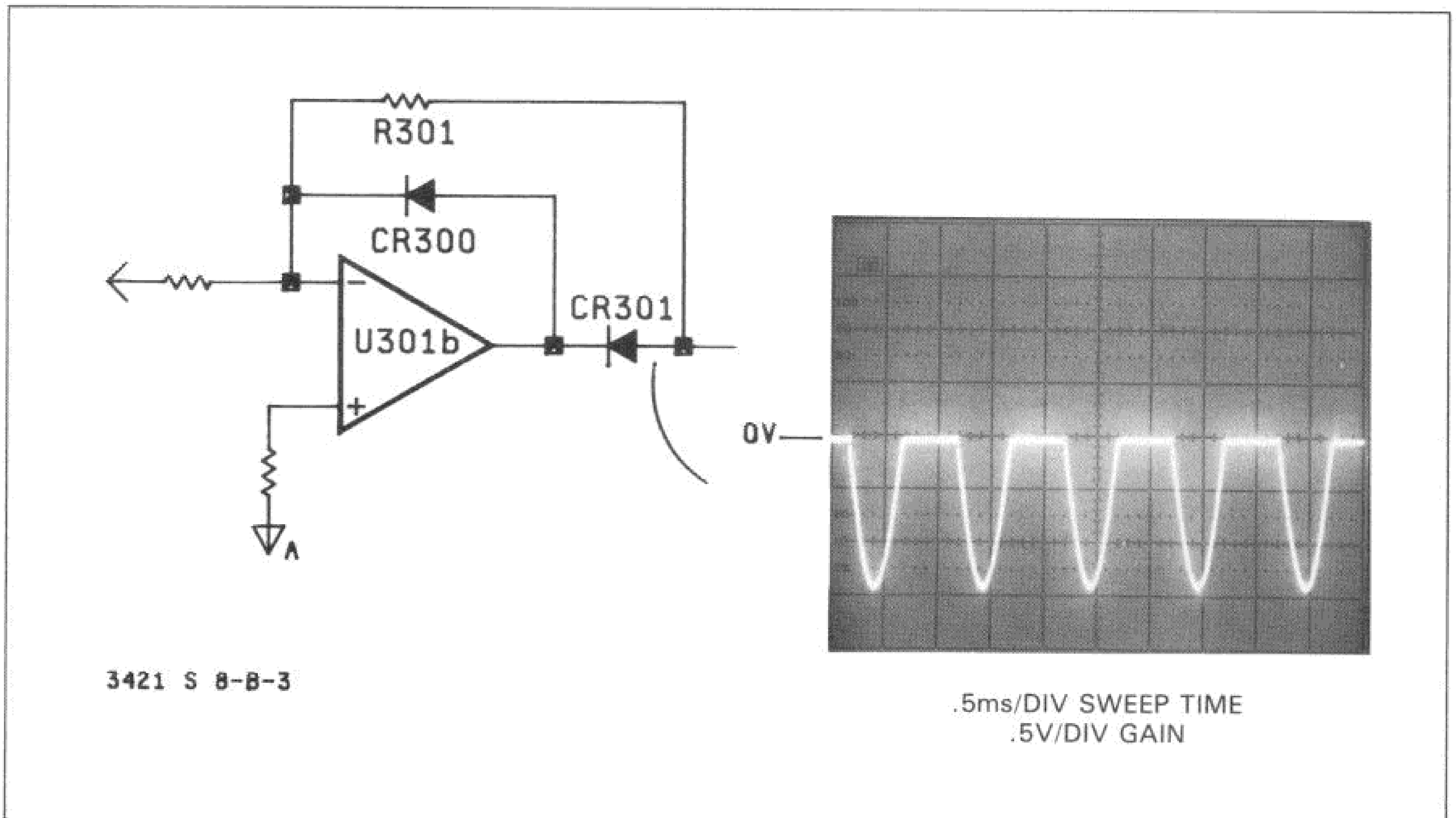



**Figure 1-8-B-3. CR301 Waveform With AC Input**

g. Check U301 pin 1 for the waveform shown in Figure 8-B-4. This figure shows a full wave rectified waveform. If it is incorrect, suspect a problem with U301. If it is correct, proceed with step h.

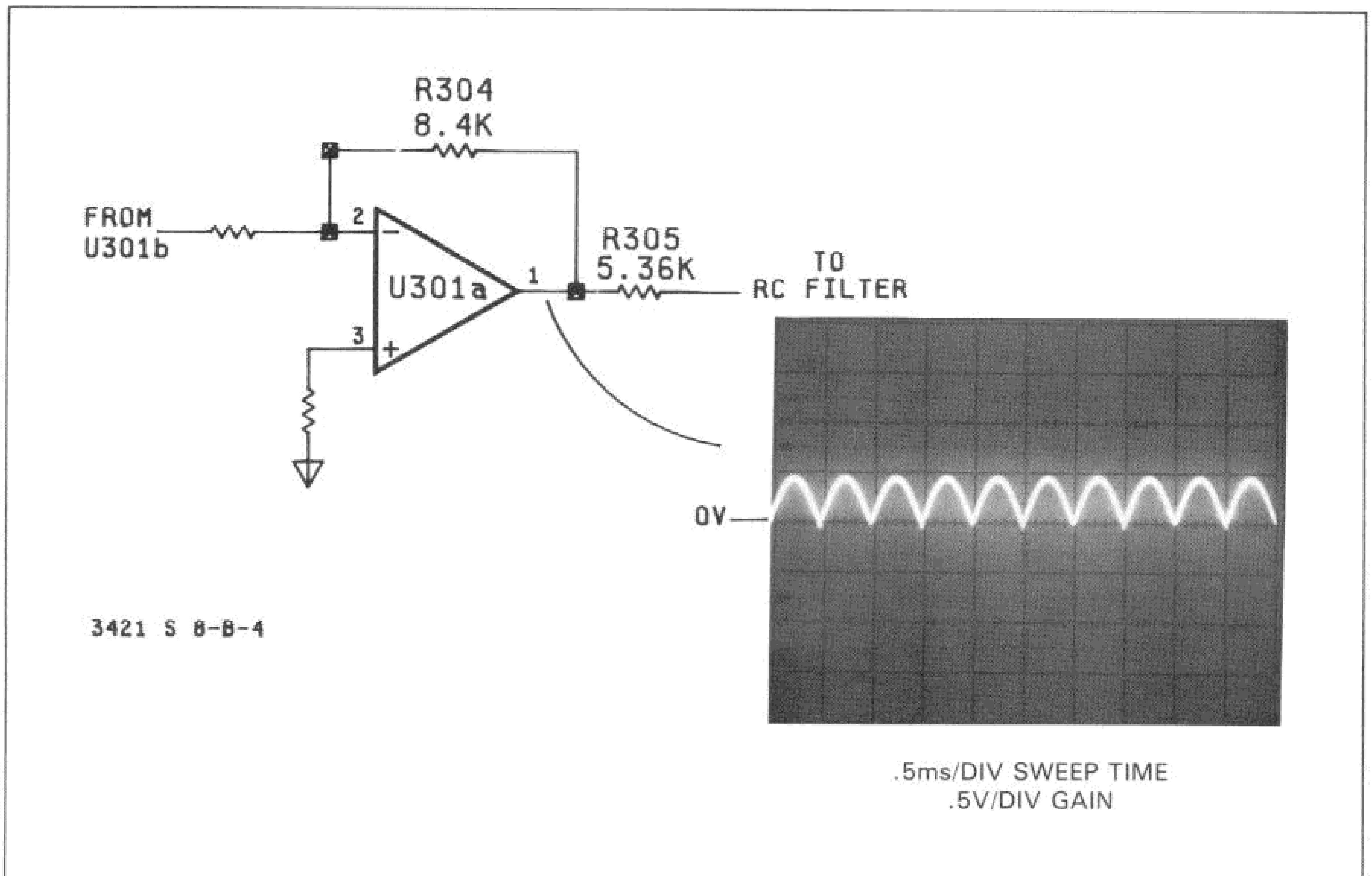



**Figure 1-8-B-4. U301 Pin 1 Waveform With AC Input**

h. To ensure K103 is going to the set state, monitor U102 pin 27 with an oscilloscope while running the following program. The program alternately selects the ohms and ac functions. It is necessary to do this because K102 is a latching type relay, which means that the set coil will only have 5V across it when the relay goes from a reset to set state. When running the program, you should see U102 pin 27 make momentary high-to-low transitions and return high again. You should also hear an audible click of the relays as they change states. If there are no transitions on U102 pin 27, replace U102. If U102 pin 27 is making transitions, then K102 is defective.

```
10 OUTPUT 901 ; "F3"
20 OUTPUT 901 ; "F2"
30 GOTO 10
40 END
```

### 1-8-C-16. Noise on All Ranges

1-8-C-17. Noise on all ranges is usually caused by a noisy ohms current. To troubleshoot this problem, perform the following procedure.

a. Connect a 3 kΩ resistor across the HP 3421A Ω/V HI and Ω/V LO front panel terminals.

b. Set the HP 3421A to the 2-wire ohms function and the 3 kΩ range by running the following program:

```
10 OUTPUT 901 ; "F3R3"
20 ENTER 901 ; A
30 DISP A
40 GOTO 20
50 END
```

c. Use a cliplead and connect U102 pin 15 (or emitter of Q201) to the HP 3421A Ω/V HI front panel terminal. If the ohms function is now quiet (i.e., the reading is steady), check Q201 through Q204. If it is still noisy, proceed with step d.

d. Using a high impedance digital voltmeter (like the HP 3456A), make sure the voltage at U201 pin 6 is a quiet +12V (< 10μV change). If it is quiet, proceed with step e. If it is noisy, check U201 pin 2 for a quiet +8V. If U201 pin 2 is quiet, then U201 is defective. If U201 pin 2 is noisy, replace U102.

e. If U201 pin 6 is quiet, measure the voltage at U202 pin 6 for a quiet +12V (< 10 μV change), keeping in mind that U202 might have a slight gain error. If U202 pin 6 is noisy, replace U202. If it is good, replace U203. If, after replacing U203, the readings are still noisy, replace U102.

### 1-8-C-18. Floating Readings on All or Some Ranges

1-8-C-19. A floating reading is usually caused by an open circuit between the HP 3421A input terminals and the input amplifier (U101). If this failure is encountered, make sure the dc volts function is operating correctly. If the failure shows up in the ohms function only, U102 may be defective.

# SERVICE GROUP C
# OHMS TROUBLESHOOTING

### Service Group C Contents



**CAUTION**

*The instrument contains CMOS integrated circuits which are susceptible to failures from static discharge. It is especially important that grounded tools and wrist straps be used when handling or troubleshooting these components.*

## 1-8-C-1. INTRODUCTION

1-8-C-2. This service group contains the ohms troubleshooting procedures for the HP 3421A and is symptoms oriented (i.e., what fails). Unless otherwise specified, refer to Schematic 1 when using the troubleshooting procedures.

1-8-C-3. Most ohms failures will affect both the 2-wire and 4-wire ohms functions. The troubleshooting procedures when both functions are failing starts with paragraph 1-8-C-8. If the failure is for 4-wire ohms only, refer to paragraph 1-8-C-26.

1-8-C-4. Before troubleshooting the ohms functions, you should understand that the HP 3421A can be calibrated for 2-wire ohms or 4-wire ohms, but not both functions at the same time. The instrument should be used in the function for which it was calibrated. Also, the instrument was calibrated at the factory for 4-wire ohms. Thus, if you are using the 2-wire ohms function and are getting inaccurate readings, re-calibrate the instrument before troubleshooting this function.

1-8-C-5. Even though the 2-wire and 4-wire ohms functions use different calibration constants, readings obtained for the 2-wire ohms function are accurate enough for troubleshooting, even if the instrument is calibrated for 4-wire ohms. A 2-wire ohms troubleshooting procedure is also easier than a 4-wire ohms procedure. Because of this, most troubleshooting procedures in this service group are for 2-wire ohms.

## 1-8-C-6. EQUIPMENT REQUIRED

1-8-C-7. The troubleshooting procedures in this service group require the following test equipment:

HP-85 Computer equipped with HP-IL or HP-IB Interface
(another controller can be used but the program lines may have to be modified for that controller)
High Impedance Digital Voltmeter (like the HP 3456A)
Oscilloscope
Variable 0-10Vdc Power Supply
Resistors (3 kΩ, 1 kΩ)

## 1-8-C-8. OHMS TROUBLESHOOTING

1-8-C-9. Ohms failures include overload, inaccurate, constant zero, floating, or noisy readings on some or all ranges. A failure normally shows up with the appropriate full scale resistor across the input. For example, an overload on the 3 kΩ range occurs when a 3 kΩ resistor is across the Ω/V HI and Ω/V LO terminals. The following paragraphs contain the troubleshooting procedures for the various ohms failures. These failures were explained at the beginning of Section VIII (see paragraph 1-8-29).

### 1-8-C-10. Overload Readings on All Ranges

1-8-C-11. An overload is usually caused by an excessive ohms current, or an open between the input terminals and the input circuitry. Make sure the dc volts function is operating properly before troubleshooting this failure. To troubleshoot this failure, perform the following procedure.

a. Connect a 3 kΩ resistor between the HP 3421A Ω/V HI and Ω/V LO terminals. Note: since the selected range will be 3 kΩ, make sure the resistor is as close to 3 kΩ as possible. If the resistor is >3.01 kΩ, the HP 3421A will return an overload reading, even if it is operating properly.

b. Configure the HP 3421A to the 2-wire ohms function and the 3 kΩ range by running the following program:

```
10 OUTPUT 901 ; "F3R3"
20 ENTER 901 ; A
30 DISP A
40 GOTO 20
50 END
```

c. With the program running, the computer should be displaying the proper reading. If this is the case, then there is not an overload problem on the 3 kΩ range. If an overload is being observed, proceed with step d.

d. With the computer indicating an overload, measure the voltage between pin 17 and pin 19 of U102 using a high impedance voltmeter like the HP 3456A. Connect the low lead of the test voltmeter to pin 17 and the high lead to pin 19.

e. If the voltage on the test voltmeter is +4Vdc while the computer is indicating an overload, the range resistors inside U102 may be out of tolerance. Replace U102.

f. If the voltage on the test voltmeter is anything other than +4Vdc, the current source is defective. Refer to paragraph 1-8-C-24 for troubleshooting.

### 1-8-C-12. Inaccurate Readings on All or Some Ranges

1-8-C-13. This failure is usually caused by the ohms current changing value with load changes. To troubleshoot this failure, perform the following procedure.

a. Connect a 3 kΩ resistor across the HP 3421A Ω/V HI and Ω/V LO terminals. Note: since the selected range will be 3 kΩ, make sure the resistor is as close to 3 kΩ as possible.

b. Set the HP 3421A to the 2-wire ohms function and the 3 kΩ range by running the following program:

```
10 OUTPUT 901 ; "F3R3"
20 ENTER 901 ; A
30 DISP A
40 GOTO 20
50 END
```

c. The first check is to make sure that Q205 is not shorted. If Q205 is shorted, too much ohms current will be shunted to ground thereby causing the reading to be inaccurate. If Q205 is good, proceed with step d.

d. Using a high impedance digital voltmeter (like the HP 3456A), measure the voltage across R204. Since the ohms current on the 3 kΩ range is 1 mA, the voltage across R204 should be about .47Vdc (470 Ω X 1 mA).

e. If the voltage is radically wrong, the ohms current source is probably at fault, although R204 may have opened or changed value. Use the overload troubleshooting procedure to determine the faulty circuit (see paragraph 1-8-C-10). If the voltage across R204 is good, proceed with step f.

f. Remove the 3 kΩ resistor from the HP 3421A front panel terminals. Then place a short across the two front panel terminals.

g. Measure the voltage across R204 again. It should still read about .47Vdc. If the voltage across R204 has changed, the output PMOS FET (inside U102), or the overvoltage protection transistors (Q201-Q205) may be defective. First make sure that Q201 through Q205 are good. The actual circuit voltages for these transistors are not given because they will vary considerably as the load changes. Check the transistors for junction shorts and opens. If Q201-Q205 are good, replace U102.

### 1-8-C-14. Constant Zero Readings on All Ranges

1-8-C-15. Constant zero readings are usually caused when the ohms current source does not supply any current. Since no current goes through the resistor to be measured, no voltage drop is developed across the resistor, and therefore the HP 3421A returns a zero reading. A no current condition can be caused by an open circuit in the ohms current source path, or by a defective ohms current source. To troubleshoot constant zero readings, perform the following procedure.

a. Connect a 3 kΩ resistor across the HP 3421A front panel Ω/V HI and Ω/V LO terminals.

b. Set the HP 3421A to the 2-wire ohms function and the 3 kΩ range by running the following program:

```
10 OUTPUT 901 ; "F3R3"
20 ENTER 901 ; A
30 DISP A
40 GOTO 20
50 END
```

c. Use a cliplead and connect pin 15 of U102 (or emitter of Q201, which is easier to access) to the HP 3421A Ω/V HI front panel terminal. If the reading is still constant zero, the ohms current source is defective, in which case you should go to paragraph 1-8-C-24 for troubleshooting. If the ohms function is now operating properly, there is an open in the current source path in which case you should proceed with step d.

d. Disconnect the cliplead from pin 15 of U1020 (emitter of Q201). Connect it to the collector of Q204 or Q203. Leave the other end of the cliplead connected to the Ω/V HI terminal. If a constant zero reading is displayed, check for an open Q201 through Q204. If the ohms functions is operative, proceed with step e.

e. Disconnect the cliplead from the collector of Q204 or Q203. Connect it to the cathode of CR201. If a constant zero reading is displayed, check for an open CR201. If the ohms functions is operative, proceed with step f.

f. Disconnect the cliplead from the cathode of CR201. Connect to the junction of L201 and R204. If a constant zero reading is displayed, check for an open L201. If the ohms functions is operative, proceed with step g.

g. Disconnect the cliplead from the junction of L201 and R204. Connect it to the other side of R204 (the side of R204 that connects to K102 pin 10). If a constant zero reading is displayed, check for an open R204. If the ohms functions is operative, either K103 is defective, or K103 is not going to a set state when the ohms function is selected. If K103 is not going to the set state, proceed with step h.

h. To ensure K103 is going to the set state, monitor U102 pin 27 with an oscilloscope while running the following program. The program alternately selects the ohms and ac functions. It is necessary to do this because K102 is a latching type relay, which means that the set coil will only have 5V across it when the relay goes from a reset to set state. When running the program, you should see U102 pin 27 make momentary high-to-low transitions and return high again. You should also hear an audible click of the relays as they change states. If there are no transitions on U102 pin 27, replace U102. If U102 pin 27 is making transitions, then K102 is defective.

```
10 OUTPUT 901 ; "F3"
20 OUTPUT 901 ; "F2"
30 GOTO 10
40 END
```

### 1-8-C-16. Noise on All Ranges

1-8-C-17. Noise on all ranges is usually caused by a noisy ohms current. To troubleshoot this problem, perform the following procedure.

a. Connect a 3 kΩ resistor across the HP 3421A Ω/V HI and Ω/V LO front panel terminals.

b. Set the HP 3421A to the 2-wire ohms function and the 3 kΩ range by running the following program:

```
10 OUTPUT 901 ; "F3R3"
20 ENTER 901 ; A
30 DISP A
40 GOTO 20
50 END
```

c. Use a cliplead and connect U102 pin 15 (or emitter of Q201) to the HP 3421A Ω/V HI front panel terminal. If the ohms function is now quiet (i.e., the reading is steady), check Q201 through Q204. If it is still noisy, proceed with step d.

d. Using a high impedance digital voltmeter (like the HP 3456A), make sure the voltage at U201 pin 6 is a quiet +12V (< 10μV change). If it is quiet, proceed with step e. If it is noisy, check U201 pin 2 for a quiet +8V. If U201 pin 2 is quiet, then U201 is defective. If U201 pin 2 is noisy, replace U102.

e. If U201 pin 6 is quiet, measure the voltage at U202 pin 6 for a quiet +12V (<10 μV change), keeping in mind that U202 might have a slight gain error. If U202 pin 6 is noisy, replace U202. If it is good, replace U203. If, after replacing U203, the readings are still noisy, replace U102.

### 1-8-C-18. Floating Readings on All or Some Ranges

1-8-C-19. A floating reading is usually caused by an open circuit between the HP 3421A input terminals and the input amplifier (U101). If this failure is encountered, make sure the dc volts function is operating correctly. If the failure shows up in the ohms function only, U102 may be defective.

### 1-8-C-20. Overload, Noise, or Constant Zero Readings on Some Ranges

1-8-C-21. When failures occur on some ranges, it can only be caused by the input hybrid (U102). This is because U102 is used to configure the current source for the different ranges. If at least one range is good, the ohms current source is operating.

### 1-8-C-22. OHMS OVERVOLTAGE PROTECTION CIRCUITRY TROUBLESHOOTING

1-8-C-23. This circuitry protects the ohms current source from excessive positive or negative input voltages. CR201 provides protection for positive input voltages; Q201 through Q205 provide protection for negative input voltages. To make sure the circuitry is operational, check the following:

a. To check the circuitry operation for positive input voltages, do the following:

1. Set the HP 3421A to the 2-wire ohms function and the 3 kΩ range by executing the following program line:

```
OUTPUT 901 ; "F3R3"
```

2. Connect a 1 kΩ resistor from pin 15 of U102 to ground. This step will shunt the ohms current to ground.

3. Using a high impedance voltmeter (like the HP 3456A), measure the voltage across the 1 kΩ resistor. The voltage should be about 1Vdc (1 kΩ X 1 mA). The actual voltage will depend upon the exact value of the resistor. If the voltage across the 1 kΩ resistor is wrong, the current source is defective. Refer to paragraph 1-8-C-24 for troubleshooting. If it is good, proceed with step 4.

4. Set the variable 0-10Vdc power supply for a 0V output. Connect the positive terminal of the power supply to the HP 3421A Ω/V HI terminal, and the low lead to the Ω/V LO terminal.

5. While monitoring the voltage across the 1 kΩ resistor, gradually adjust the power supply to an output of + 10V. If the voltage across the 1 kΩ resistor remains the same as the power supply voltage is increased, the positive overvoltage protection circuit is operating properly. If the voltage does not remain the same, check CR201, Q203, Q202 (in the order given). If these are good, check the remaining transistors in the overvoltage protection circuit (Q201, Q204, and Q205).

b. To check the circuitry operation for negative input voltages, do the following:

1. Leave the set up the same as in step a, except return the power supply to 0V output. The voltage across the 1 kΩ resistor should be 1V.

2. Reverse the power supply output leads.

3. With the power supply set to 0V, check the voltage across R204, which should be 0V because all of the ohms current is shunted to ground through the 1 kΩ resistor.

4. Increase the power supply output to −10V while observing the voltage across the 1 kΩ resistor. This voltage should now read about .4V. The reason the voltage changes is because the power supply, with a negative output, should now sink some of the ohms current. This reduces the current through the 1 kΩ resistor, and thereby reduces the voltage drop across it.

5. If the voltage across the 1 kΩ resistor does not change, check the source and drain voltage of Q205 for a −.6V (from ground). If Q205 is good, check Q201 through Q204. If the voltage across the 1 kΩ resistor checked good, proceed with step 6.

6. Now check the voltage across R204, which should have increased from 0V to about .3V as a result of the power supply sinking more current. If it is good, the ohms over-voltage protection circuit is operating properly. If it is low, check Q201 through Q205.

## 1-8-C-24. OHMS CURRENT SOURCE TROUBLESHOOTING

1-8-C-25. The ohms current source consists of a voltage reference (U201), buffer (U202), gate bias amplifier (U203), range resistors (in U102), and ouput PMOS FET (inside U102). Before troubleshooting the ohms current source, check the +10V reference supply at TP401 for +10V ±.5V. If the +10V reference is wrong, refer to Service Group F for troubleshooting. To troubleshoot the ohms current source, perform the following procedure.

a. Set the HP 3421A to the 2-wire ohms function and the 3 kΩ range by executing the following program line:

```
OUTPUT 901 ; "F3R3"
```

b. With a high impedance digital voltmeter (like the HP 3456A), measure the voltage at pin 2 and pin 3 of U203 (U102 pins 17 and 18, respectively). The voltage on both pins should be approximately +8Vdc.

c. If the two voltages are not very close to the same value (regardless of what the value is), replace U203.

d. If the two voltage are wrong (other than +8V), but are approximately the same value, do the following:

1. Measure for approximately +12V at pin 6 of U201. If it is correct, replace U102. If it is wrong, proceed with step 2.

2. Measure for +8 at U201 pin 3. If it is wrong, replace U102. If the voltage is correct, proceed with step 3.

3. Connect U201 pin 6 to U201 pin 2 (U102 pin 6 to pin 7).

4. Measure for approximately +8V at U201 pin 6. If it is correct, replace U102. If it is incorrect, replace U201.

e. If the voltages on both pins of U203 are approximately +8V, do the following:

1. Connect a 3 kΩ resistor across the HP 3421A Ω/V HI and Ω/V LO terminals.

2. Measure for approximately +12V at pin 6 of U202. If the voltage is wrong, connect U202 pin 6 to pin 2 (U102 pins 19 and 21).

3. If U202 pin 6 is now good, replace U102. If it is still wrong, replace U202.

f. If the ohms current source is still inoperative, replace U203. If it is still inoperative after replacing U203, replace U102.

### 1-8-C-26. 4-Wire OHMS TROUBLESHOOTING

1-8-C-27. The major differences between the 4-wire and 2-wire ohms functions is that the 4-wire ohms function uses the front panel ohms sense terminals and a different input path inside U102. Make sure the wires from the front panel terminals are connected properly. Also, make sure the lead resistance on all leads used for 4-wire ohms measurements are not excessive (< ⅓ of full scale reading on the Ω/V LO lead and < ⅓ of full scale on the Ω/V HI lead). If everthing appears to be good, U102 is probably defective.

# SERVICE GROUP D
# A/D CONVERTER TROUBLESHOOTING

### Service Group D Contents



**CAUTION**

*The instrument contains CMOS integrated circuits which are susceptible to failures from static discharge. It is especially important that grounded tools and wrist straps be used when handling or troubleshooting these components.*

## 1-8-D-1. INTRODUCTION

1-8-D-2. This service group contains the A/D (analog to digital) converter troubleshooting procedures. An A/D converter failure will probably be detected during self test. If the A/D self test segment fails, it will be indicated by display segment 3 and the display error indicator. See the explanation on self test (paragraph 1-8-21).

1-8-D-3. The A/D converter consists of the A/D hybrid (U403), integrator (U401), and DAC resistors (R401-R406). The A/D section uses +5V, and the +10V and −10V reference power supplies.

## 1-8-D-4. EQUIPMENT REQUIRED

1-8-D-5. The troubleshooting procedures for the A/D converter require the following equipment:

HP-85 Computer equipped with HP-IL or HP-IB Interface
(another controller can be used but the program lines
may have to be modified for that controller)
Oscilloscope (storage capabilities preferred)
High Impedance Digital Voltmeter (like the HP 3456A)
3Vdc Power Supply
1 10 kΩ Resistors

## 1-8-D-6. PRE-TROUBLESHOOTING CHECKS

1-8-D-7. Before troubleshooting the A/D converter, do the following:

a. Check the +5V and reference power supplies as outlined in Table 1-8-D-1. If any of these supplies are out of tolerance refer to Service Group F for troubleshooting.

**Table 1-8-D-1. +5V and Reference Power Supplies**

| Power Supply | Check At | Tolerance |
|---|---|---|
| +5V | TP +5V | ±.25V |
| +10V Reference | TP 401 | ±.5V |
| −10V Reference | TP 400 | ±.5V |
| −10V Buffered | U404 Pin 6 | ±.5V |

b. Since the CPU (U508) controls the A/D converter, make sure the LRST line (TP LRST) is high. If the line is low, the CPU is being held in a reset state, in which case you should go to Service Group E for troubleshooting.

c. Use an oscilloscope and check ALE at U508 pin 11 for the waveform shown in Figure 1-8-D-1. If ALE is incorrect or missing, refer to Service Group E for troubleshooting.

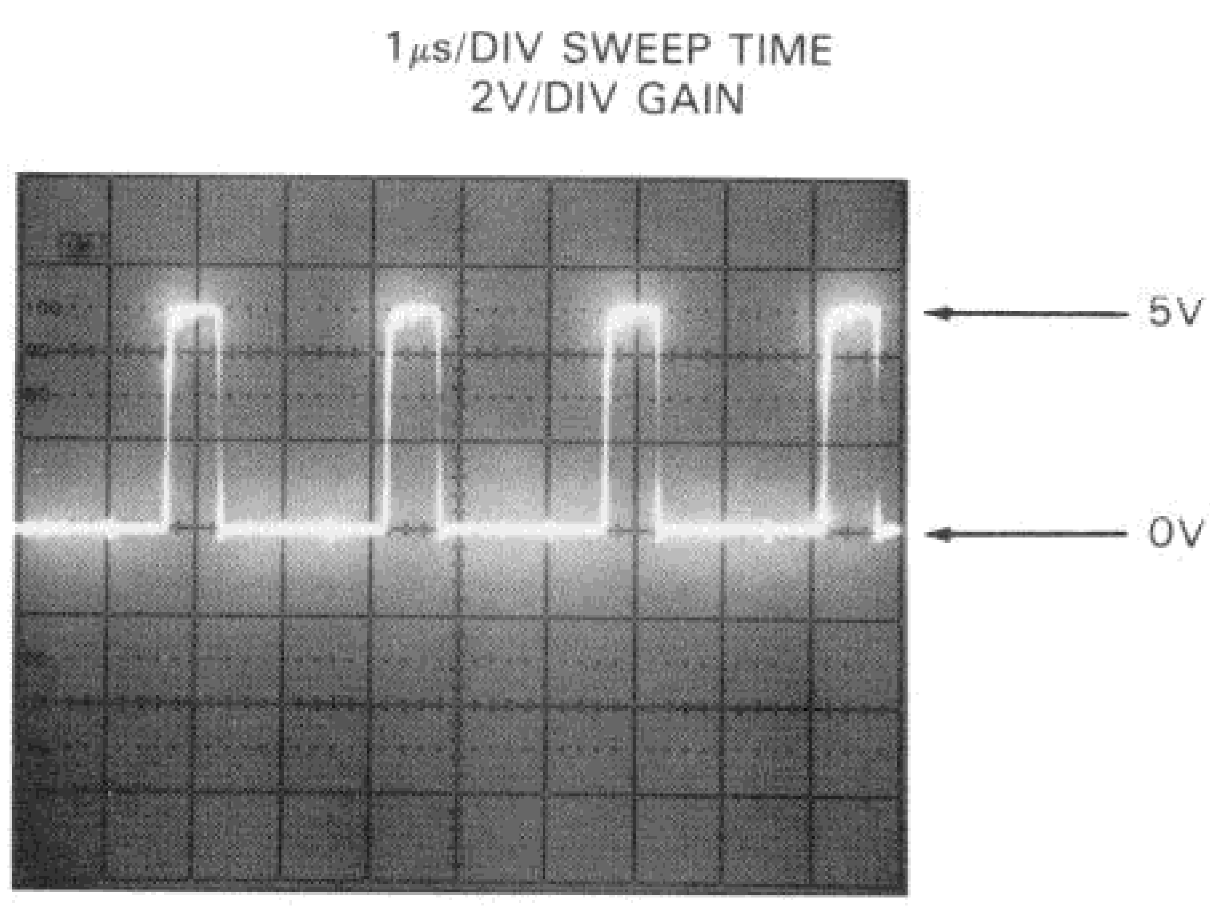



**Figure 1-8-D-1. ALE at U508 Pin 11**

d. If the +5V, +10V and −10V reference voltages, LRST, and ALE are correct, it will be necessary to troubleshoot the A/D converter circuitry. This is explained in the following paragraphs.

## 1-8-D-8. TROUBLESHOOTING THE A/D CONVERTER

1-8-D-9. There are two procedures for troubleshooting the A/D converter. The first, beginning with paragraph 1-8-D-10, checks only the integrator (U401). If the integrator is good, U403 is probably defective. The second procedure, beginning with paragraph 1-8-D-12, allows you to check the integrator (U401) output waveform for a specified dc input, and the output of the U403 comparator with no input.

### 1-8-D-10. Integrator (U401) Test

1-8-D-11. An integrator failure can cause readings that are constant zero, constant overload, or erronous. To check the U401 integrator, do the following:

a. Connect a 10 kΩ resistor across (in parallel with) C410.

b. Unsolder and lift one end of JM401.

c. Using a short cliplead, connect pin 2 of U401 to TP401 (i.e., the + 10 V Reference).

d. Measure the voltage at U401 pin 6 for approximately – 10V. If the voltage is incorrect, replace U401. If the voltage is correct, proceed with step e.

e. Disconnect the clip lead from TP401 ( + 10 V Reference) and connect it to TP400 ( – 10 V Reference).

f. Measure the voltage at U401 pin 6 for approximately + 10V. If the voltage is incorrect, replace U401. If it is correct, the integrator is operating properly.

g. Remove the 10 kΩ resistor and cliplead, and replace JM401.

### 1-8-D-12. Integrator/Comparator Waveforms

1-8-D-13. Use this procedure to check the A/D converter waveforms, specifically the waveforms of the integrator and comparator. An oscilloscope with storage capabilities, such as the -HP- Model 1741A would be beneficial, although an oscilloscope without storage capabilities will suffice. To check the waveforms do the following:

a. Configure the HP 3421A for dc volts, 3 volt range, and autozero off by running the following program:

```
10 OUTPUT 901 ; "F1R0Z0"
20 ENTER 901 ; A
30 DISP A
40 GOTO 20
50 END
```

b. Use a 3 Vdc power supply and apply 3 volts across the HP 3421A Ω/V HI and Ω/V LO front panel terminals. Connect the positive lead of the power supply to the Ω/V HI terminal and the negative lead to the Ω/V LO terminal.

c. Set the oscilloscope for 5 ms/div sweep time and 2V/div vertical gain, and then monitor U401 pin 6 for the waveform shown in Figure 1-8-D-2. Note: to obtain this waveform the HP 3421A must be configured as outlined in step a, and the dc input voltage must be 3V. Also, the waveform appears only when a trigger occurs (i.e., the ENTER statement of the program is executed). Thus, the waveform will not be a steady display on the oscilloscope, which is the reason a storage oscilloscope is preferred. If the waveform is incorrect, replace U401. If it is correct, proceed with step d.

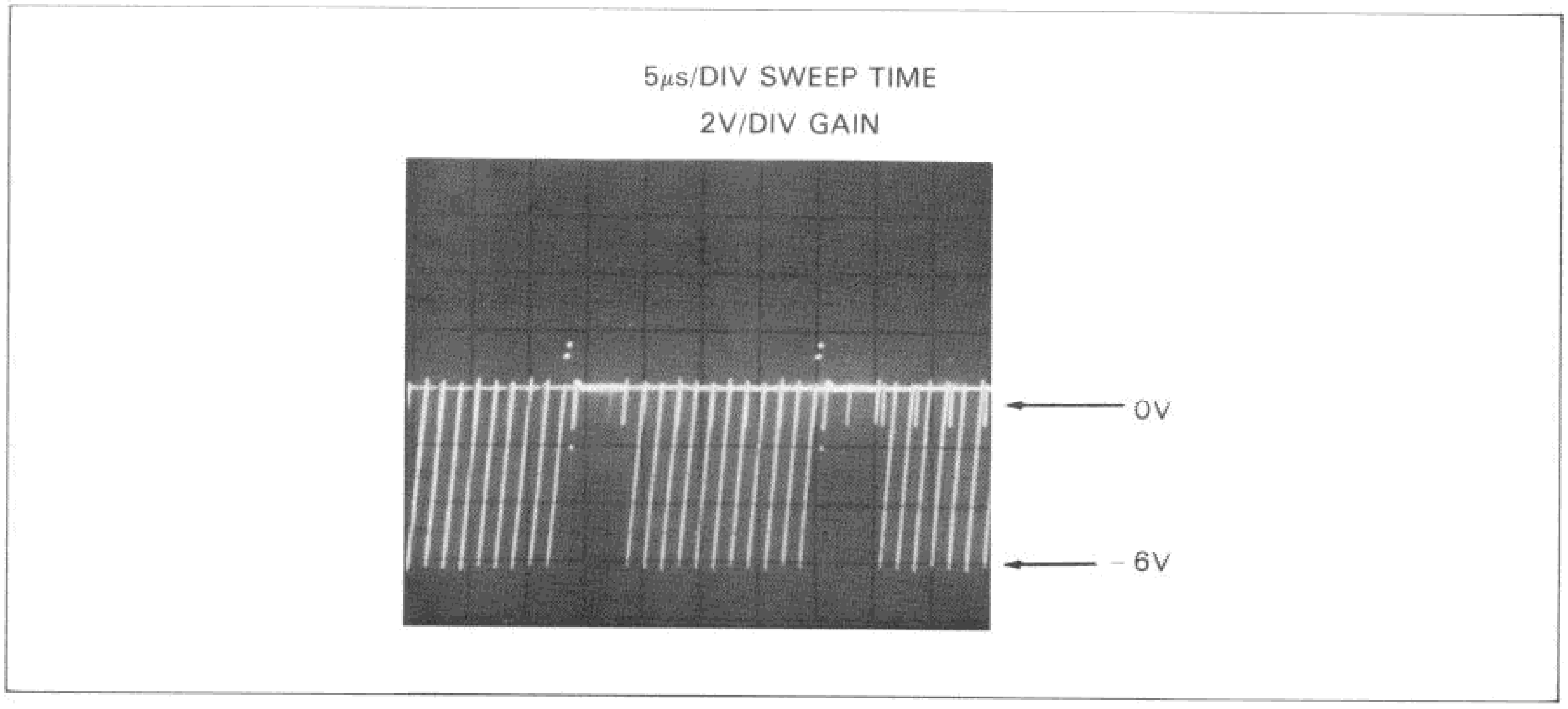



**Figure 1-8-D-2. Integrator Output Waveform (U401 pin 6)**

d. Pause the program.

e. Using the oscilloscope DELAY feature with a sweep time of .1 ms/Div, monitor the output of the comparator (U403 pin 11) for the waveform shown in Figure 1-8-D-3. Note: unless program execution is halted, the waveform will be different than what is shown in Figure 1-8-D-3, and it may be difficult to view. This comparator waveform is a result of zeroing the integrator when readings are not being taken. If the waveform is incorrect, replace U403.

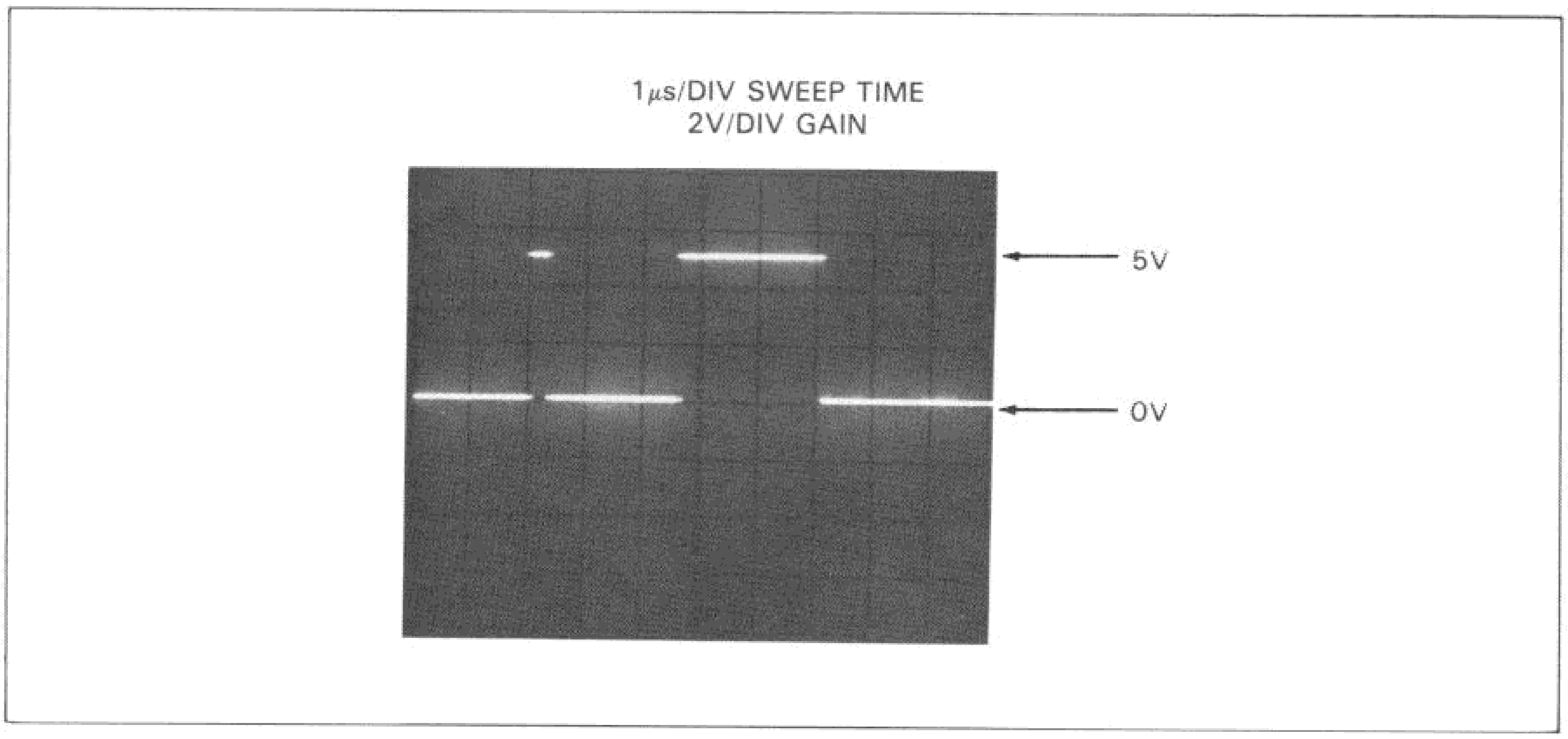



**Figure 1-8-D-3. Comparator Output Waveform (U403 pin 11)**

### 1-8-D-14. Other A/D Failures

1-8-D-15. If U401 and/or U403 are replaced and there is still a problem with the A/D converter, the problem might be the CPU (U508), port expander (U512), or U513. Refer to Service Group E to check these components.

# SERVICE GROUP E
# COUNTER
# POWER ON RESET
# AND
# CONTROL LOGIC
# CIRCUITRY
# TROUBLESHOOTING

## SERVICE GROUP E CONTENTS



**CAUTION**

*The instrument contains CMOS Integrated Circuits which are susceptible to failure from static discharge. It is especially important that grounded tools and wrist straps be used when handling or troubleshooting CMOS components.*

### 1-8-E-1. INTRODUCTION

1-8-E-2. This service group contains the troubleshooting procedures for the counter, power on reset, and control logic circuitry. This circuitry is located on schematic 2. The schematic 2 power supply circuitry (Battery Backup and Cal RAM Battery Backup) is explained in Service Group F. The power supply wakeup logic is also explained in Service Group F.

1-8-E-3. Most of the control logic troubleshooting procedures use signature analysis (SA). The HP 3421A SA routines are built-in and include a free run mode, plus two other levels (SA1 and SA2). The SA tests are explained starting with paragraph 1-8-E-32.

1-8-E-4. Some of the troubleshooting procedures in this service group are performed without SA. These procedures are for the counter and power on reset circuitry.

1-8-E-5. The troubleshooting procedures that do not require SA are explained first, followed by the SA procedures.

## 1-8-E-6. EQUIPMENT REQUIRED

1-8-E-7. The troubleshooting procedures in this service group use the following equipment:

HP-85 Computer equipped with HP-IL or HP-IB Interface
(another controller can be used but the program lines
may have to be modified for that controller)
Dual Trace Oscilloscope
Digital Voltmeter (HP 3456A recommended)
Signal Generator (used to troubleshoot the counter circuitry)
HP 5004A Signature Analyzer (for the SA routines)

## 1-8-E-8. COUNTER CIRCUITRY TROUBLESHOOTING

1-8-E-9. This circuitry consists of U581 and associated components. The output of the counter is routed to the T1 input of the U508 CPU. The counter is used to count events (transitions), and totalize.

1-8-E-10. To troubleshoot the counter circuitry, do the following:

a. Configure the HP 3421A to frequency and a one second gate time by running the following program:

```
10 OUTPUT 901 ; "F7G0"
20 ENTER 901 ; A
30 DISP A
40 GOTO 20
50 END
```

b. Input a 10 kHz ac signal with an amplitude of 220 mV RMS to the Ω/V HI and Ω/V LO front panel terminals. The actual frequency and amplitude of the input signal is not that important. However, the waveforms obtained will be different than those shown in this procedure unless the input frequency and amplitude are 10 kHz at 220mV RMS.

c. If the computer is displaying the proper frequency with the program running (i.e., 10 kHz), the counter function is operating properly. If the computer is not displaying the correct frequency, proceed with step d.

d. Use an oscilloscope set to 2V/div and a sweep time of 50 μs/div and monitor U581 pin 7 for the square wave shown in Figure 1-8-E-1. If the waveform is incorrect or non-existent, proceed with step e. If it is correct but the counter function does not operate properly, replace U508.

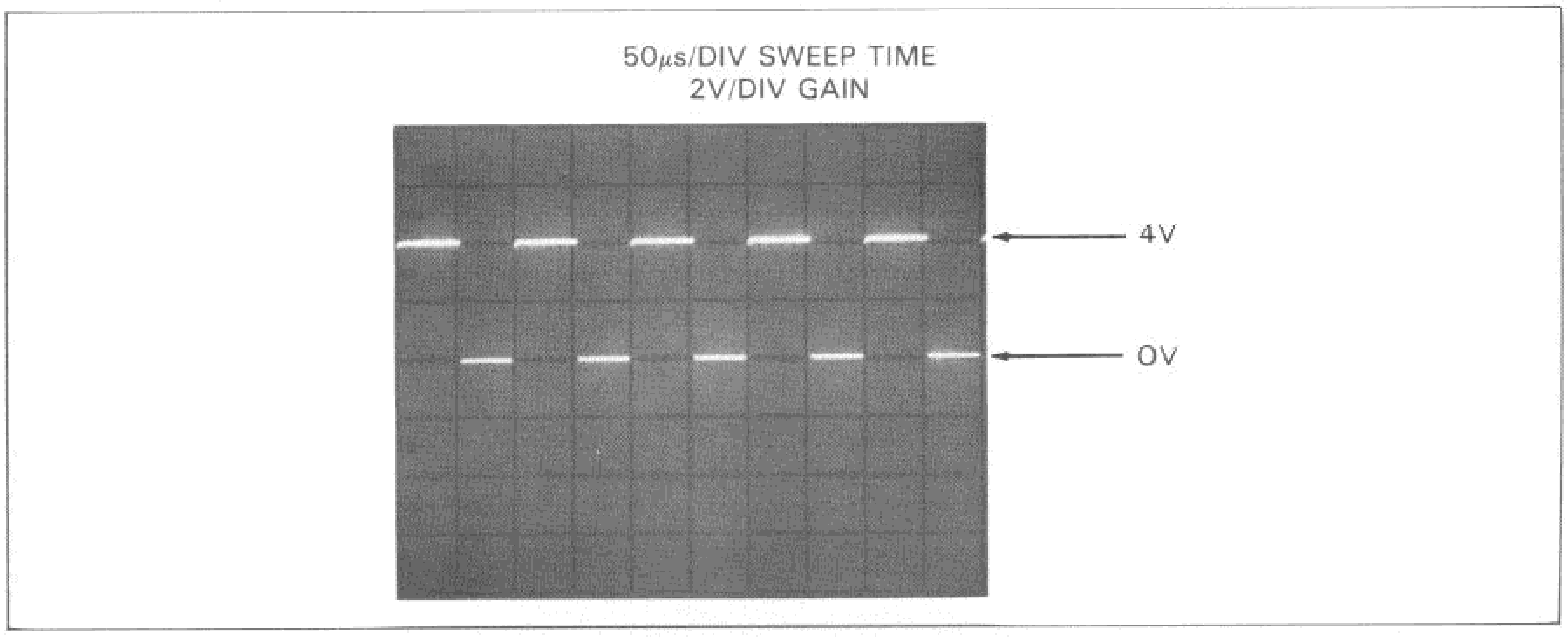



**Figure 1-8-E-1. Counter Output Waveform**

e. Change the oscilloscope to .5V/div and check U581 pin 5 for the waveform shown in Figure 1-8-E-2. If it is correct, replace U581.

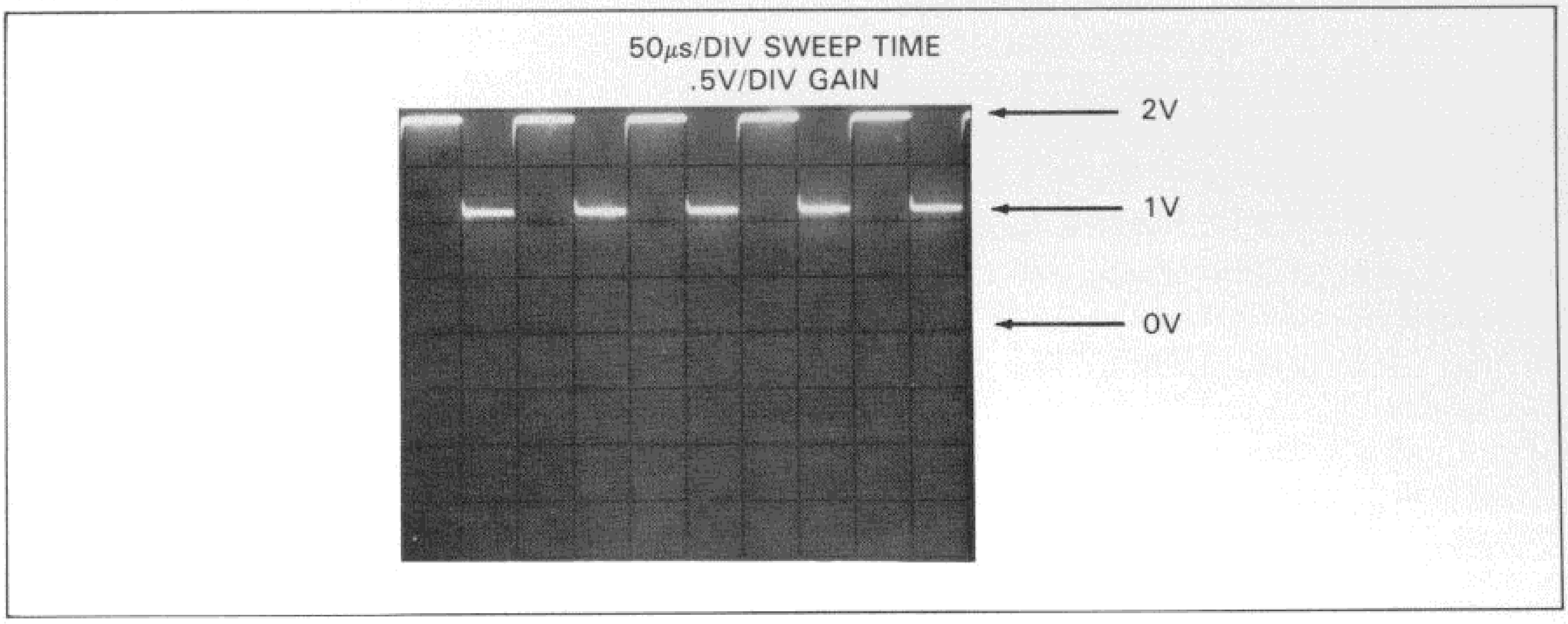



**Figure 1-8-E-2. Counter Waveform At U581 pin 5**

f. If the waveform at U581 pin 5 is wrong or non-existent, check U101 pin 6 for the waveform shown in Figure 1-8-E-3. If U101 pin 6 is correct, replace C581. If U101 pin 6 is incorrect or non-existent, there is a problem in the input circuitry. Make sure the dc volts function is operating properly.

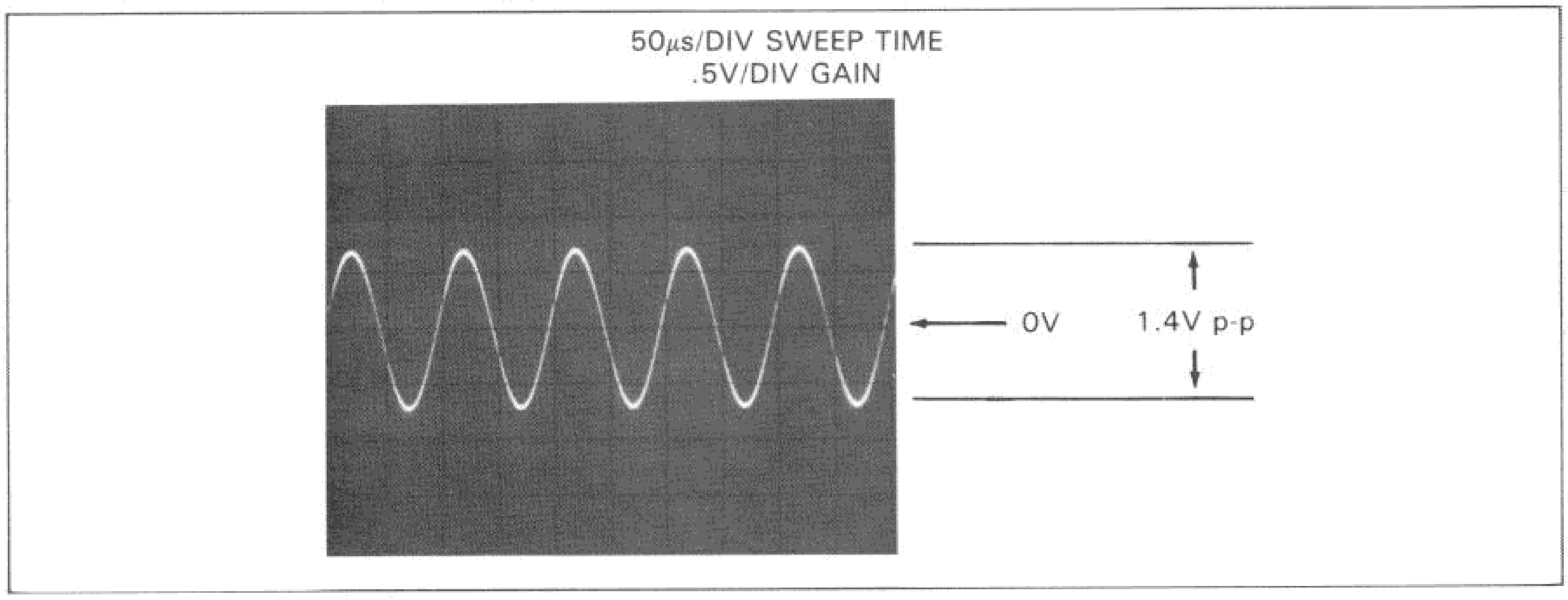



**Figure 1-8-E-3. Counter Waveform At U101 pin 6**

g. If the waveform at U101 pin 6 is correct but U581 pin 5 is incorrect, check the components associated with the input of U581, including C581.

## 1-8-E-11. POWER ON RESET CIRCUITRY TROUBLESHOOTING

1-8-E-12. The RESET circuitry consists of U514B and associated components. Its purpose is to RESET the CPU to address location 3000 Hex at power on (i.e., when the front panel switch is pressed on, or the rear panel switch is pressed in and then released). When a RESET occurs, the instrument goes through self test.

1-8-E-13. If this circuitry fails, the instrument will probably be locked up, and thereby not respond to commands. To troubleshoot this circuitry, do the following:

a. With the front panel switch off, check TP LRST for 0V.

b. Press the front panel switch on and check to see if if TP LRST goes to +5V. If it does, the RESET circuit is operating properly. If TP LRST goes to +5V but the instrument is still locked up, there is most likely a problem with the control logic. If TP LRST does not go to +5V at power on, do the following:

1. Make sure the front panel switch is on.

2. Check U514 pin 2 for approximately 4.3V. If it is correct, proceed with step 3. If U514 pin 2 is incorrect, make sure TP VB is between 5.8V and 7.6V. If TP VB is incorrect, go to Service Group F for troubleshooting. If U514 pin 2 is wrong but TP VB is good, replace CR507.

3. Check TP +5V for 5V (±.25V). If TP +5V is correct, proceed with step 4. If TP +5V is incorrect, go to Service Group F for troubleshooting.

4. Check C513. If is is good, replace U514.

## 1-8-E-14. CONTROL LOGIC CIRCUITRY TROUBLESHOOTING

1-8-E-15. This circuitry can be found on schematic 2. Signature Analysis (SA) is the most effective way to troubleshoot this circuitry. However, there are some other things you can do if you are not equipped to use SA.

### 1-8-E-16. Where To Start

1-8-E-17. Whether or not you are equipped to use signature analysis, there are some checks you should always make if you suspect a control logic problem. First, always make sure the power supplies are correct and stable. If the power supplies are good, perform the pre-troubleshooting checks.

**1-8-E-18. Power Supply Checks.** Always check the power supplies before attempting to troubleshoot a suspected control logic failure. The various power supply voltages are outlined in Table 1-8-E-1. If any power supply voltage is incorrect, refer to Service Group F for troubleshooting.

**Table 1-8-E-1. Power Supply Voltages**

| Power Supply | Checked At | Tolerance |
|---|---|---|
| +5V | TP +5 | ±.25V |
| +15V | TP +15 | ±.4V |
| −15V | TP -15 | ±.25V |
| VB | TP VB | +5.8V to +7.6V |
| VBATT | TP VBATT | +5.8V to +7.6V |

**1-8-E-19. Pre Troubleshooting Checks.** In addition to the power supplies, always perform the following checks before troubleshooting the control logic.

a. Make sure the front panel switch is on.

b. Check U508 pin 6 (CPU interrupt line (LINT)) to make sure it is high (+5V). If the instrument is operating properly, it will power down anytime LINT goes low (0V). Furthermore, LINT is only activated when the front panel switch is pressed off. Therefore, if LINT is low when the front panel switch is on, replace S502.

c. Set the sweep time of an oscilloscope to .05 μs/div and a gain of 2V/div. For HP 3421A's with Serial Prefix 2236 and below, check the CPU clock at pins 2 and 3 of U508. Check for the correct frequency (6.003 MHz) and amplitude as shown in Figure 1-8-E-4. For HP 3421A's with Serial Prefix 2247 and above, check only the clock signal at pin 2 of U508. If the CPU clock is incorrect, go to paragraph 1-8-E-20.

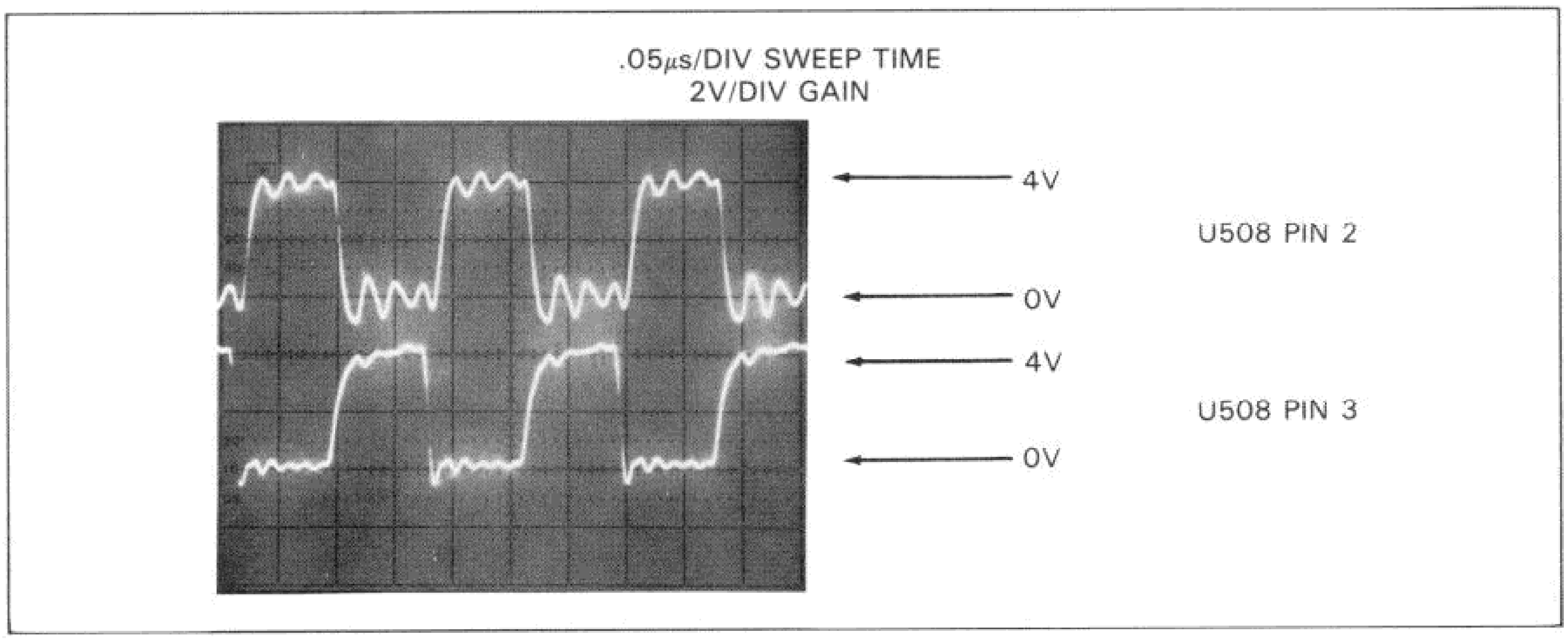



**Figure 1-8-E-4. CPU Clock at U508 pins 2 and 3**

d. Using an oscilloscope set to a sweep time of 1 μs/div and a gain of 2V/div, check U508 pin 11 (ALE) for the waveform shown in Figure 1-8-E-5. If ALE is wrong, the problem is most likely U508, although the problem could be U507 or U403.

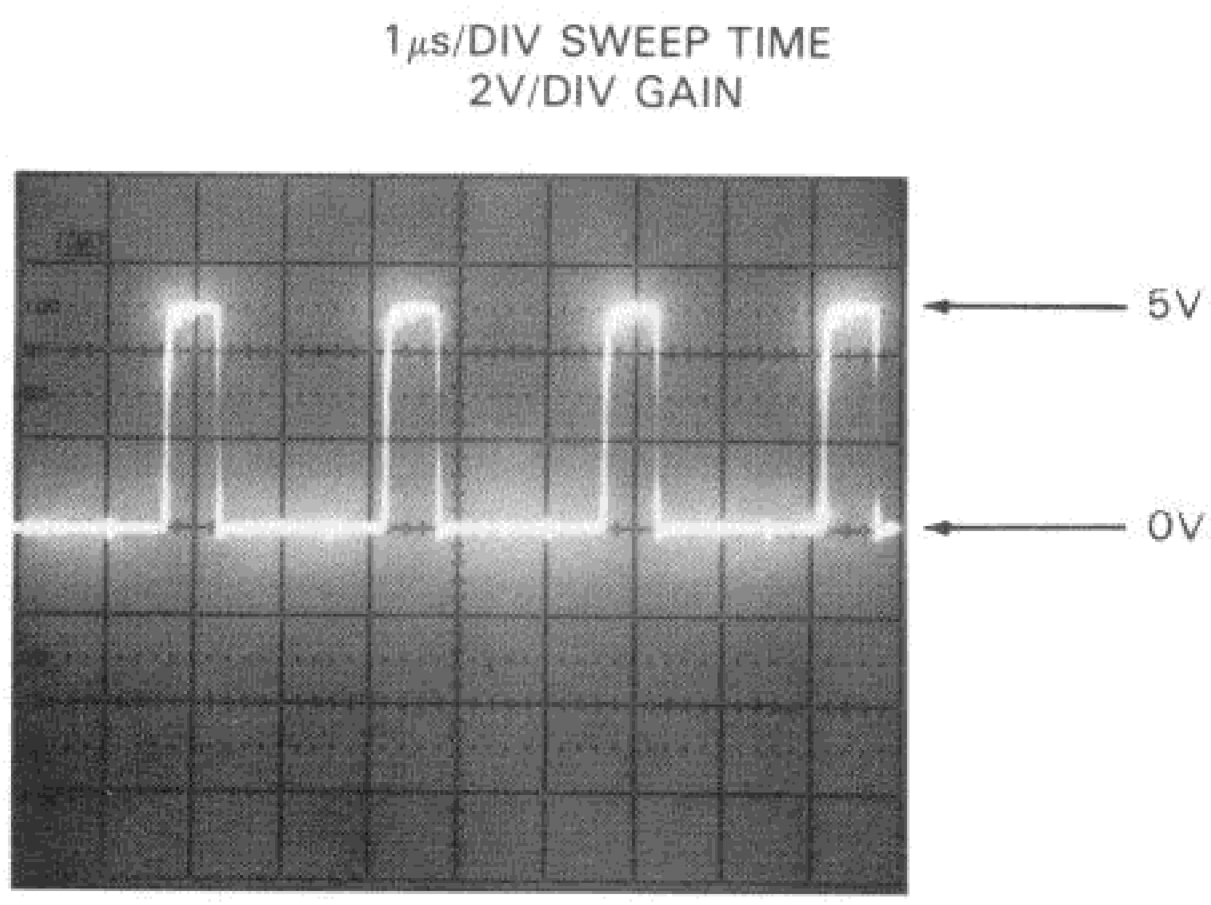



**Figure 1-8-E-5. ALE at U508 pin 11**

e. Using an oscilloscope set to a sweep time of 1 μs/div and a gain of 2V/div, check TP 506 (PSEN) for the waveform shown in Figure 1-8-E-6. If it is wrong, the problem is most likely U508, although the problem could be U509.

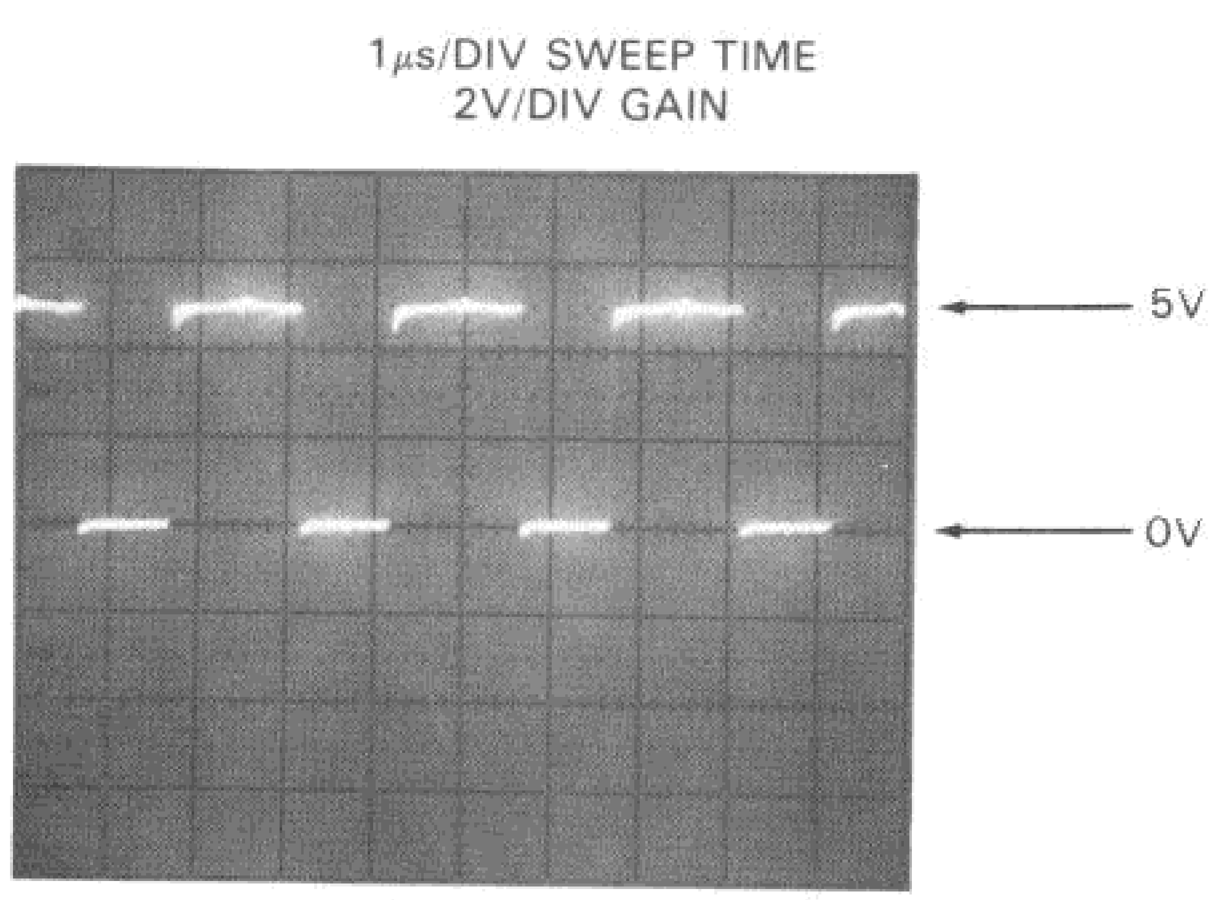



**Figure 1-8-E-6. TP 506 (PSEN)**

f. Using an oscilloscope set to a sweep time of .2 ms/div and a gain of 2V/div, check TP 503 (PT25) for the waveform shown in Figure 1-8-E-7. If it is wrong, the problem is most likely U508, although the problem could be U509.

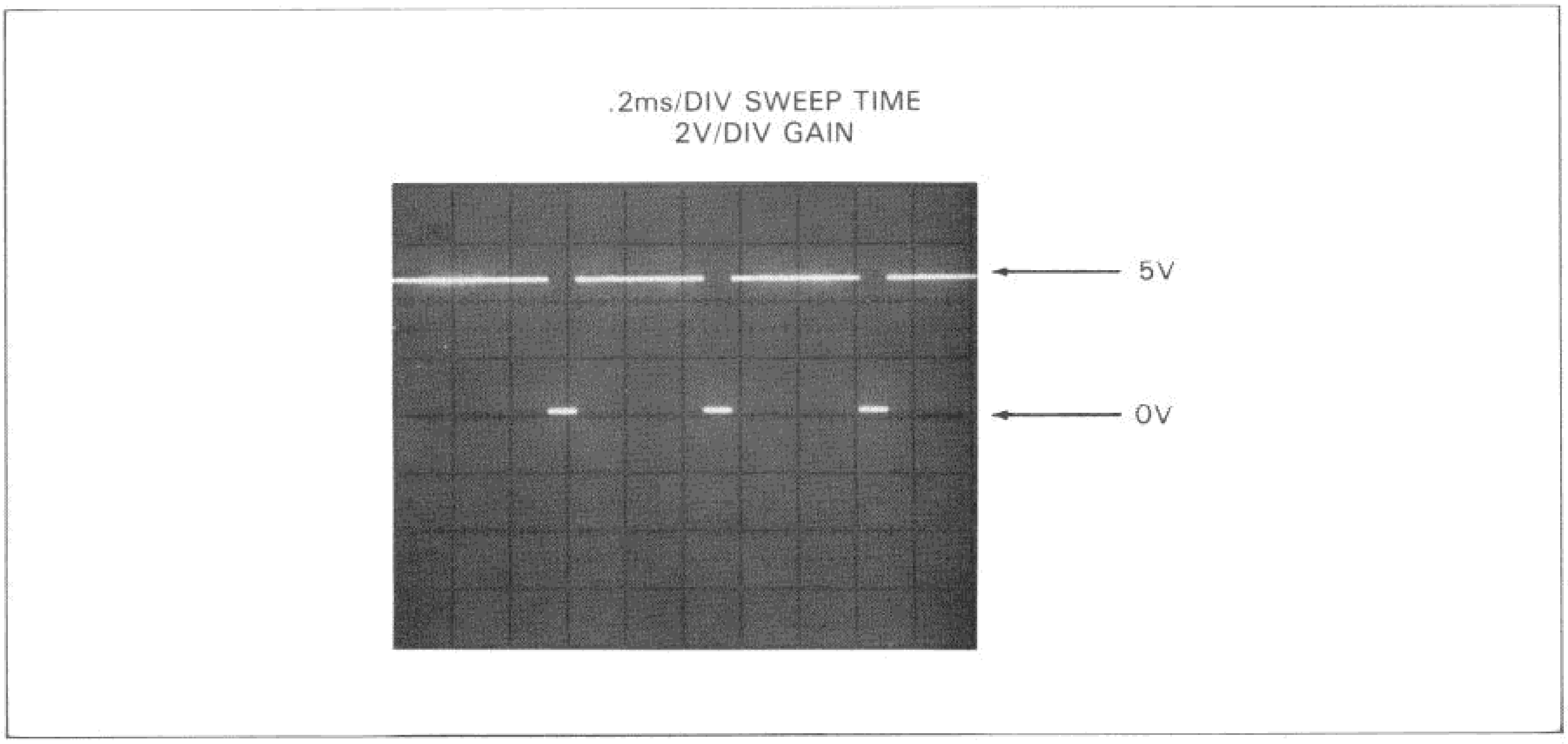



**Figure 1-8-E-7. TP 503 (PT25)**

g. Check TP LRST for +5V (±.5V). If it is incorrect, refer to paragraph 1-8-E-11 for troubleshooting.

### 1-8-E-20. CPU Clock Circuitry Troubleshooting

1-8-E-21. The CPU clock waveforms that should appear at U508 pins 2 and 3 were shown in Figure 1-8-E-4. If these were incorrect or non-existant, do the following:

a. Using an oscilloscope set to a sweep time of .05 μs/div and a vertical gain of 2V/div, check U510 pin 1 (or the emitter of Q504) for the waveform shown in Figure 1-8-E-8. If it is incorrect, proceed with step b. If it is correct, replace U510.

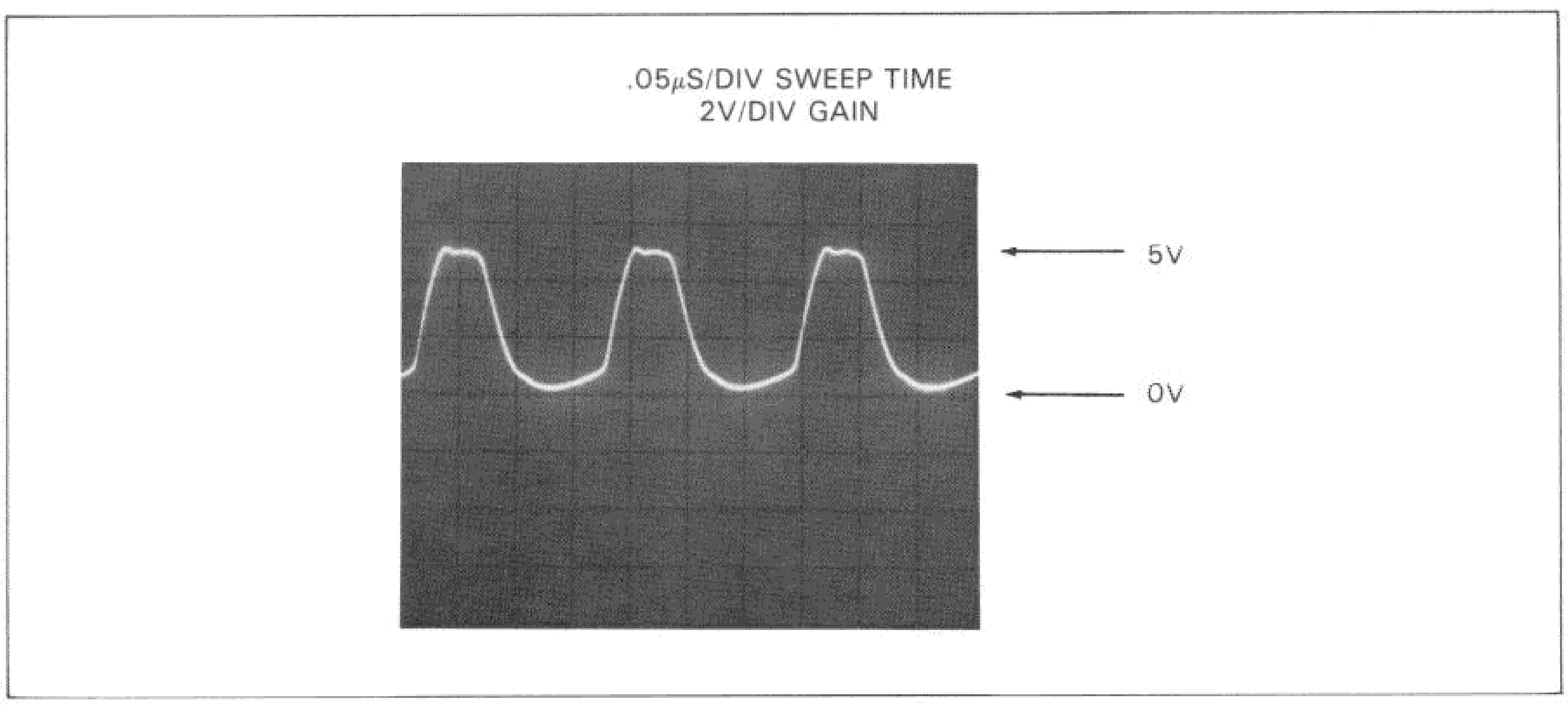



**Figure 1-8-E-8. CPU Clock at U510 pin 1**

b. Using an oscilloscope set to a sweep time of .05 $\mu$s/div and a vertical gain of 2V/div, check the base of Q504 for the waveform shown in Figure 1-8-E-9. If it is incorrect, first check C511 and C512. If the capacitors are good, replace Y501. If the waveform at the base of Q504 is correct, replace Q504.

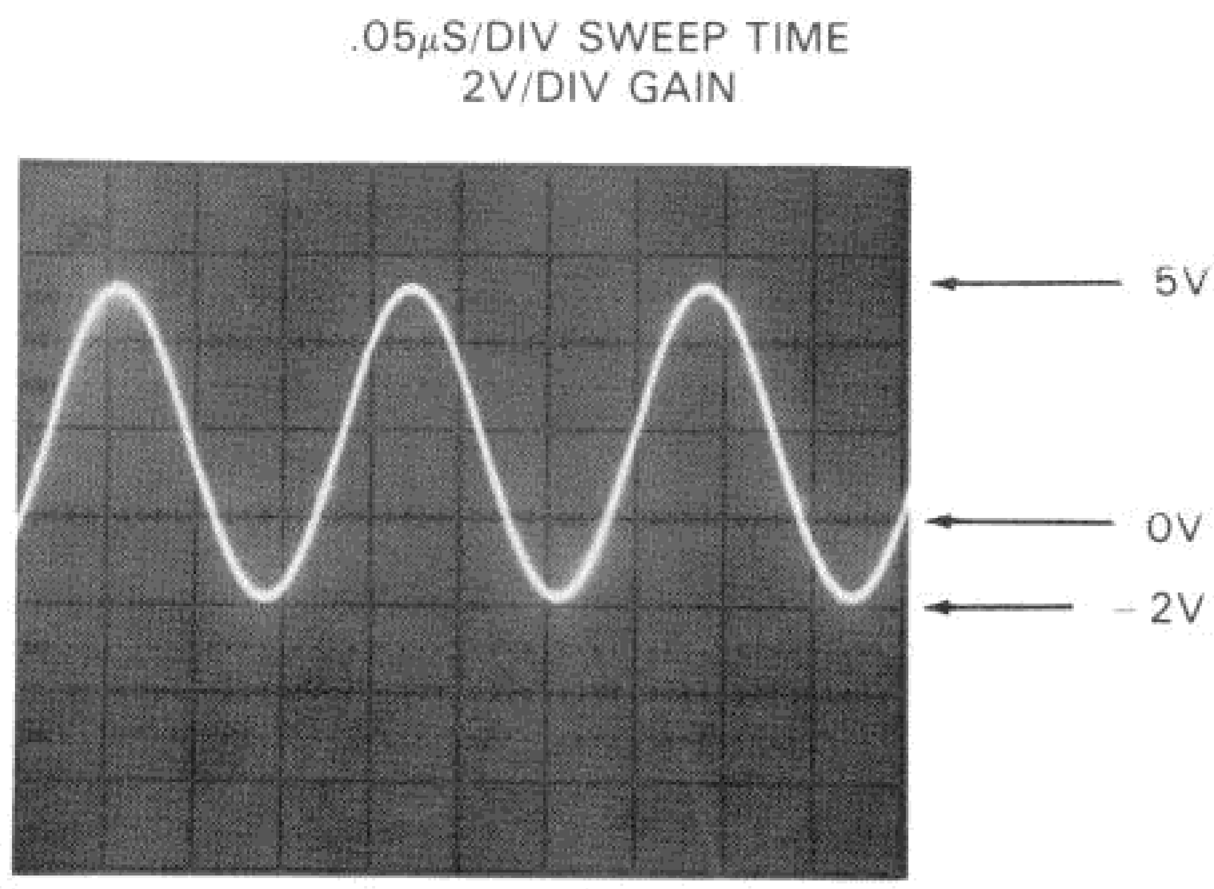



**Figure 1-8-E-9. CPU Clock at Base of Q504**

### 1-8-E-22. Troubleshooting With Signature Analysis

1-8-E-23. With the increased use of microprocessors, the complexity of signal timing and bus structures make the oscilloscope and/or voltmeter troubleshooting techniques difficult to use in some cases. Hewlett-Packard has developed the signature analysis technique to enhance the serviceability of microprocessor based products.

1-8-E-24. Signature Analysis, commonly referred to as SA, is based on the premise that the data bit stream is predictable at a given point in a circuit if specific programming conditions are met. The data at a given point in a circuit is analyzed over a controlled period (window). This results in a unique four character signature which is displayed on the signature analyzer. If the signature matches the one listed for that test, then that part of the circuitry is operating properly. If the signatures do not match, some circuit component is probably defective. However, this may not be the case, as explained in the following paragraph.

### 1-8-E-25. Incorrect Signatures

1-8-E-26. Finding an incorrect signature does not necessarily mean that the devices connected to that circuit node are defective. Some previous device may be providing incorrect signals, or your setup may be incorrect. Also, it could be that the signature you are reading does not match the one listed for that test because some component(s) used in the original design has been substituted, or a circuit design change may have taken place. Remember, a signature merely reflects the data present over a very controlled period. Thus, if the circuitry has been changed, the signatures have probably changed too. The best way to approach this potential problem is to make sure you have the manual that is applicable to the instrument serial number you are troubleshooting.

### 1-8-E-27. Types of Incorrect Signatures

1-8-E-28. Common digital circuit failures include stuck lines. A line can be stuck at 0V (low or GND), +5V (high), or anywhere between 0V and +5V. In any event, a stuck line does not make transitions. Depending upon the level of the stuck line, and because of the threshold requirements of the signature analyzer, a stuck line will indicate either a GND, or +5V signature. Also, the probe tip may be on, off, or even flickering when a stuck line is encountered, depending upon the level where it is stuck. You should also keep in mind that some signatures noted in the tables that follow are indicated as GND or +5V signatures. When these are noted in the signature tables, they are valid signatures.

1-8-E-29. To find the defective device connected to a circuit node that is stuck low, first make sure the inputs to the device are good. If an input is bad, trace the bad signal back to its source. If the inputs are good, use a high resolution voltmeter and probe the devices connected to the node that is stuck low. The defective device will be sinking the most current, and therefore will usually have the largest voltage at its pin connected to the circuit node that is stuck low. This voltage is developed by the current going through the trace to the pin of the defective device.

1-8-E-30. If the node is stuck high, first make sure the inputs to the device are good. If an input is bad, trace the bad signal back to its source. However, if the inputs are good, it could be any device connected to the node that is stuck high that is defective. A general rule here is to suspect the sourcing device, although this may not always be the problem.

1-8-E-31. Another type of incorrect signature is one that is different than the one listed for the circuit node under test, but it is not a GND or +5V signature. This can be caused by incorrect timing, data, etc.. If this type of signature is encountered, it should be traced to its source. That is, use the schematics and trace back through the circuitry until you find the location where the incorrect signal starts. When you find the component where its output signature is wrong but its input signature(s) is good, replace that device.

### 1-8-E-32. Signature Analysis Tests

1-8-E-33. The HP 3421A has three SA tests, SA1, SA2, and Freerun. Use the Freerun Test if unable to run SA1 or SA2, or if a wrong signature is found when checking ROM or RAM in the SA1 test. For these, use the Freerun Test to isolate the problem.

1-8-E-34. SA1 allows you to check ROM0 (U506), ROM1 (U505), ROM Enable Gate (U509), XRAM (U503 and U504), CPU (U508), Address Latch (U507), Port Expander Enable (U510C or U510D in early instruments), and the Port Expanders (U511, U512). SA2 allows you to check the Port Expanders (U511, U512), HP-IL chip (U501), and Cal RAM (U502). It should be noted that if the Cal RAM is tested using the SA2 Test, the calibration constants will be altered, requiring instrument re-calibration. However, you can run the SA2 test without testing Cal RAM.

1-8-E-35. It may not be necessary to run SA. The flowchart shown in Figure 1-8-E-10 is a power on sequence that should guide you in getting where you need to be for troubleshooting. Refer to the flowchart and follow this procedure:

a. Make sure all options are removed from the instrument. The SA procedures in this chapter will NOT check options.

b. Make sure nothing is connected to the front panel input terminals.

c. Press the front panel switch on and observe the front panel display to see if self test passes. Self test is discussed in detail at the beginning of Section VIII (see paragraph 1-8-21).

d. If self test passes but the instrument is failing some function (dc volts, ac volts, etc.), refer to the service group for the function that is bad, as outlined in the flowchart (Figure 1-8-E-10).

e. If one or more self test segments fail, proceed with step g. Otherwise, proceed with step f.

f. If the instrument locks up at turn on (i.e., it does not perform self test), the display could have any or all of its segments on (or off). If the instrument locks up at power on, do the following:

1. First check all the power supplies as outlined in paragraph 1-8-E-18. If they are correct, proceed with step 2. If any of the supplies are incorrect, go to Service Group F for troubleshooting.

2. If the supplies are OK, run the Freerun SA Test. This is outlined starting with paragraph 1-8-E-65.

g. See the self test discussion (paragraph 1-8-21).

h. If a self test segment(s) fails, it will be either an analog or digital failure. Analog failures include A/D slope error, indicated by display segment 3; 10 MΩ Test, indicated by display segment 7; or Low Battery, indicated by display segment 27 (and a power down 3 seconds later). If the failure is analog, there is no need to run an SA test. Instead, refer to the appropriate service group depending upon the analog failure, as outlined in the flowchart.

i. If the self test failure is digital and you want to check the signatures for the failure, refer to the appropriate paragraph as outlined in the flowchart. Other signatures that are available include port expander enable lines for U511 and U512, and the HP-IL chip.

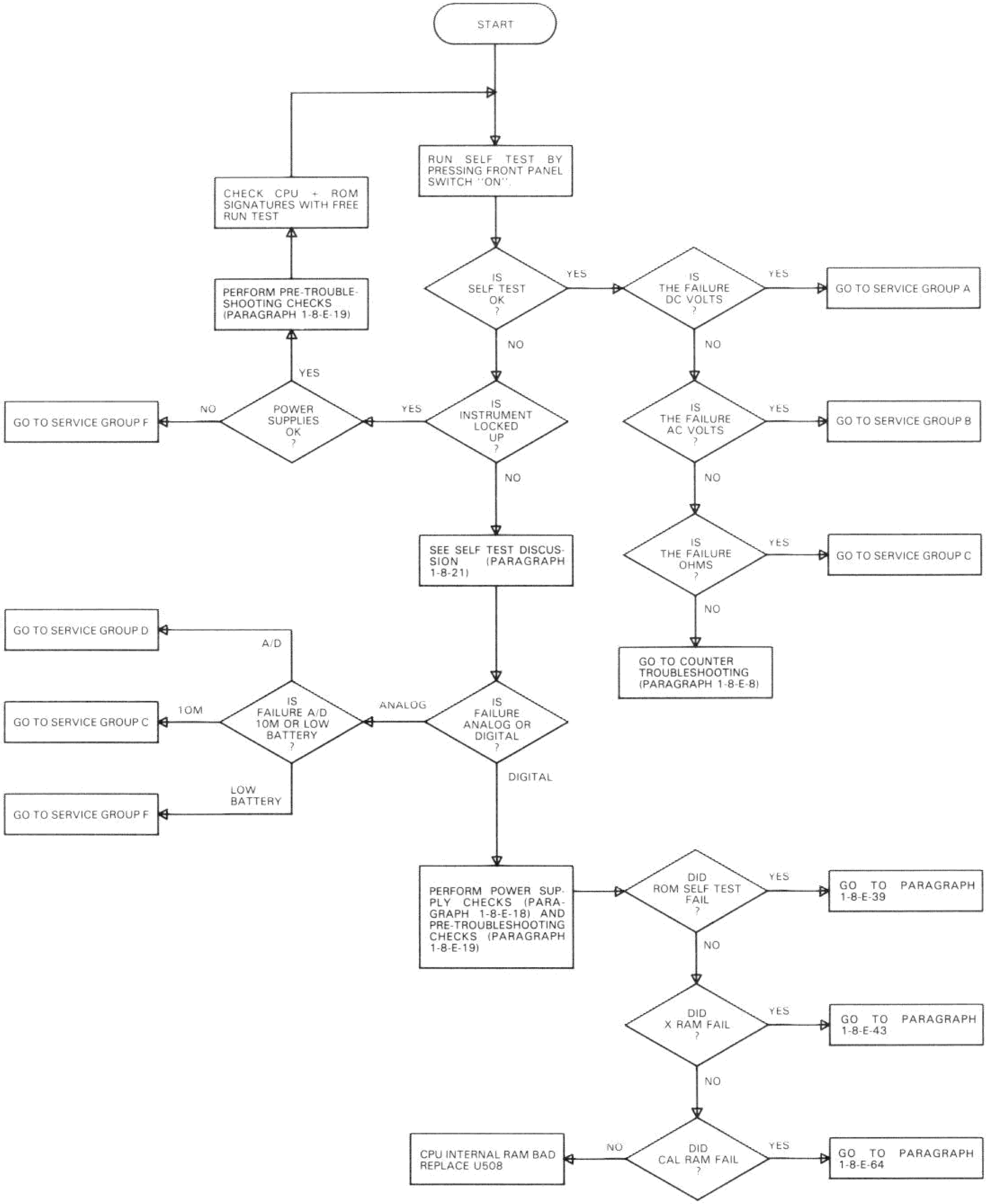



**Figure 1-8-E-10. Power-On Sequence**

### 1-8-E-36. SA1 Test

1-8-E-37. SA1 allows you to verify the signatures for the following ICs:

ROM (U505 and U506)
Address Latch (U507)
CPU (U508)
XRAM (U503 and U504)
Port Expander Enable (U510C or U510D in early instruments)
Port Expander 0 (U512)
Display at P501

1-8-E-38. You should check the SA1 signatures in the order given, unless you suspect a display problem, in which case you should refer to paragraph 1-8-E-53. The display (and circuitry that drives the display) is probably OK if all of the display segments turn on for a brief period during self test. Also, display segments 0, 1, 2, 3, 4, 5, 6, and 7 should turn on when you are running an SA routine.

### 1-8-E-39. Data Bus Signatures

1-8-E-40. In the SA1 Test, data bus signatures are generated by either the ROM (U505, U506) or XRAM (U503 and U504). Each set of signatures requires a different setup.

**1-8-E-41. ROM Data Bus Signatures.** To check these signatures, do the following:

a. Make sure all segments of the rear panel switch (S501) are in the up position.

b. Connect TP 509 (U508 pin 1) to ground. Early instruments do not have TP 509, in which case you should connect U508 pin 1 to ground.

c. Make sure E501 is in place.

d. Set the signature analyzer as follows:

Start = ‾_ (in)
Stop = _/‾ (out)
Clock = _/‾ (out)

e. Connect the signature analyzer as follows:

Start to J504 ST
Stop to J504 SP
Clock to TP 506

f. If the motherboard part number is 03421-66501, move switch segment 4 of switch S501 to the down position. If the motherboard part number is 03421-66511, move switch segment 1 of S501 to the down position.

g. Cycle power by pressing the front panel switch off and then on.

h. If the motherboard part number is 03421-66501, move switch segment 4 of switch S501 to the up position. If the motherboard part number is 03421-66511, move switch segment 1 of S501 to the up position.

i. Assuming that the display is operating properly, display segments 0, 1, 2, 3, 4, 5, 6, and 7 should be on. This ensures the instrument is running an SA routine. If these display segments are not on, repeat this setup. If these display segments still do not turn on after repeating the setup, there may be a problem with the display, display connector, or the circuitry that drives the display. See paragraph 1-8-E-53.

1-8-E-42. You are now ready to check the ROM data bus signatures. These signatures are listed in Table 1-8-E-2. If all signatures are correct, the ROM is being addressed properly and is providing good data. Proceed to the XRAM data bus signatures (paragraph 1-8-E-43). If any signature is incorrect, you should perform the Freerun Test. If the Freerun Test has already been performed and the Freerun Test signatures were correct, but there was an incorrect ROM data bus signature in SA1, the CPU internal RAM is probably bad, in which case you should replace U508.

**NOTE**

*Make sure the Freerun SA Test is or has been performed, if any signatures in Table 1-8-E-2 are incorrect or if you are unable to read any signatures at all.*

**Table 1-8-E-2. ROM Data Bus Signatures (SA1 Test)**

+5V Signature: 3428

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U505(9) | A7F5 | U506(9),U504(10), U502(9,10),U501(14), U508(12),U507(18), E501(3,14),RP501(13) |
| D1 | Data Bit 1 | U505(10) | 8UA8 | U506(10),U504(11.12), U502(11,12),U501(13), U508(13),U507(17), E501(4,13),RP501(4) |
| D2 | Data Bit 2 | U505(11) | C484 | U506(11),U504(13,14), U502(13,14),U501(12), U508(14),U507(14), E501(7),RP501(7) |
| D3 | Data Bit 3 | U505(13) | PA56 | U506(13),U504(15,16), U502(15,16),U501(11), U508(15),U507(13), E501(8.9),RP501(8) |
| D4 | Data Bit 4 | U505(14) | UU78 | U506(14),U503(9.10), U501(9),U508(16), U507(8),E501(6,11), RP501(6) |
| D5 | Data Bit 5 | U505(15) | 4PU7 | U506(15),U503(11.12), U501(8),U508(17), U507(7),E501(5,12), RP501(5) |
| D6 | Data Bit 6 | U505(16) | FCU4 | U506(16),U503(13,14), U501(7),U508(18), U507(3),E501(1,16), RP501(1) |
| D7 | Data Bit 7 | U505(17) | 6C2F | U506(17),U503(15,16), U501(6),U508(19), U507(4),E501(2,15), RP501(2) |

**1-8-E-43. XRAM Data Bus Signatures.** Check these signatures if the ROM data bus signatures were correct. These signatures are listed in Table 1-8-E-3. If all signatures are good, the XRAM is being addressed properly and is providing good data. If this is the case, do not check the XRAM address bus signatures. Instead, proceed to paragraph 1-8-E-48. However, if any XRAM data bus signature is incorrect, check the XRAM address bus signatures (paragraph 1-8-E-45).

1-8-E-44. To check the XRAM data bus signatures, do the following:

a. Check the display to make sure display segments 0 thru 7 are on. This ensures the instrument is running an SA routine. If the display segments are not on, perform the same setup that was explained for the ROM data bus signatures (paragraph 1-8-E-41).

b. Set the signature analyzer as follows:

Start = ⟍ (in)
Stop = ⟋ (out)
Clock = ⟋ (out)

c. Connect the signature analyzer as follows:

Start to J504 ST
Stop to J504 SP
Clock to TP 508

**1-8-E-45. XRAM Address Bus Signatures.** Check these signatures only if there was a bad XRAM data bus signature. These signatures are listed in Table 1-8-E-4. If all signatures are correct, proceed to the port expander enable line signatures (paragraph 1-8-E-48). If a bad signature is found for any address line (A0 thru A7), refer to the schematics and check that signature(s) at the output of the address latch (U507). For example, if A0 has the wrong signature at U504 pin 4, check for the signature at U507 pin 19. If the signature is correct at the output of U507, but incorrect at U504, then there is a broken trace for that line. If the signature is also wrong at the output of U507, perform the Freerun Test.

1-8-E-46. Three other signatures listed in Table 1-8-E-4 are for the XRAM Read (RD), Write (WRT), and Enable (EN) lines. If an incorrect signature is found on the RD or WRT lines, U508 is probably bad. If the EN line has an incorrect signature, the problem could be U508 or U512.

**Table 1-8-E-3. XRAM Data Bus Signatures (SA1 Test)**

+5V Signature: 3825

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U504(9,10) | 8087 | U506(9),U505(9), U502(9,10),U501(14), U508(12),U507(18), E501(3,14),RP501(3) |
| D1 | Data Bit 1 | U504(11,12) | 7U3P | U506(10),U505(10), U502(11,12),U501(13), U508(13), U507(17), E501(4,13), RP501(4) |
| D2 | Data Bit 2 | U504(13,14) | 173H | U506(11),U505(11), U502(13,14),U501(12), U508(14),U507(14), E501(7,10),RP501(7) |
| D3 | Data Bit 3 | U504(15,16) | 9CPC | U506(13),U505(13), U502(15,16),U501(11), U508(15),U507(13), E501(8,9),RP501(8) |
| D4 | Data Bit 4 | U503(9,10) | 6HC2 | U506(14),U505(14), U501(9),U508(16), U507(8),E501(6,11), RP501(6) |
| D5 | Data Bit 5 | U503(11,12) | AA31 | U506(15),U505(15), U501(8),U508(17), U507(7),E501(5,12), RP501(5) |
| D6 | Data Bit 6 | U503(13,14) | 6C9C | U506(16),U505(16), U501(7),U508(18), U507(3),E501(1,16), RP501(1) |
| D7 | Data Bit 7 | U503(15,16) | 9CAC | U506(17),U505(17), U501(6),U508(19), U507(4),E501(2,15), RP501(2) |

1-8-E-47. To check the ROM Address, RD, WRT, and EN line signatures, do the following:

a. Check the display to make sure display segments 0 thru 7 are on. This ensures the instrument is running an SA routine. If the display segments are not on, perform the same setup that was explained for the ROM data bus signatures (paragraph 1-8-E-41).

b. Set the signature analyzer as follows:

Start = ⌝_ (in)
Stop = _/‾ (out)
Clock = _/‾ (out)

c. Connect the signature analyzer as follows:

Start to J504 ST
Stop to J504 SP
Clock to TP 508

**Table 1-8-E-4. XRAM Address Bus, RD, WRT, and EN Signatures (SA1 Test)**

+5V Signature: 3825

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| A0 | Addr Bit 0 | U504(4) | U047 | U503(4),U502(4), U505(8),U506(8), U507(19),U501(5) |
| A1 | Addr Bit 1 | U504(3) | 23P1 | U503(3),U502(3), U505(7),U506(7), U507(16),U501(4) |
| A2 | Addr Bit 2 | U504(2) | 78H0 | U503(2),U502(2), U505(6),U506(6), U507(15),U501(3) |
| A3 | Addr Bit 3 | U504(1) | 560F | U503(1),U502(1), U505(5),U506(5), U507(12) |
| A4 | Addr Bit 4 | U504(21) | A233 | U503(21),U502(21), U505(4),U506(4), U507(9) |
| A5 | Addr Bit 5 | U504(5) | 341P | U503(5),U502(5), U505(3),U506(3), U507(6) |
| A6 | Addr Bit 6 | U504(6) | A3C1 | U503(6),U502(6), U505(2),U506(2), U507(2) |
| A7 | Addr Bit 7 | U504(7) | HA6C | U503(7),U502(7), U505(1),U506(1), U507(5) |
| RD | Read Line | U504(18) | 0000f | U508(8),U501(26) U502(18),U503(18), TP 508,RP501(11,12) |
| WRT | Write Line | U504(20) | 3825f | U508(10),U501(27), U502(20),U503(20), RP501(9,10),S501(9) |
| HEXR | Enable Line | U504(17) | 3825f | U512(3),U503(17) |

f indicates that the probe tip should be flashing.

**1-8-E-48. Port Expander Enable Line Signatures.** Check these signatures if the signatures in Table 1-8-E-4 were correct. The port expander enable line signatures are listed in Table 1-8-E-5 and Table 1-8-E-5A. Use Table 1-8-E-5 if the motherboard part number is 03421-66501. Use Table 1-8-E-5A if the motherboard part number is 03421-66511. If the U510 signatures are correct, check the U512 port expander signatures (paragraph 1-8-E-49). If the signature at U510 pin 5 (or U510 pin 9 on early instruments) is bad, check the signature at U508 pin 37. If U508 pin 37 has the wrong signature too, U508 is probably bad. If U510 pin 6 (or U510 pin 8 in early instruments) has the wrong signature, but U510 pin 5 (or U510 pin 9 in early instruments) has the correct signature, replace U510. To check these signatures, do the following:

a. Check the display to make sure display segments 0 thru 7 are on. This ensures the instrument is running an SA routine. If the display segments are not on, perform the same setup that was explained for the ROM data bus signatures (paragraph 1-8-E-41).

b. Set the signature analyzer as follows:

Start = ╲ (in)
Stop = ╱ (out)
Clock = ╱ (out)

c. Connect the signature analyzer as follows:

Start to J504 ST
Stop to J504 SP
Clock to J503 CLK C

**Table 1-8-E-5. Port Expander Enable Line Signatures (SA1 Test) For 03421-66501 Board**

| +5V Signature: 1H44 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| LEPX0 | Port Expander 0 Enable | U510(9) | 38F3 | U508(37),U512(6),TP 501 TP 501 |
| LEPX1 | Port Expander 1 Enable | U510(8) | 2587 | U511(6) |

**Table 1-8-E-5A. Port Expander Enable Line Signatures (SA1 Test) For 03421-66511 Board**

| +5V Signature: 1H44 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| LEPX0 | Port Expander 0 Enable | U510(5) | 38F3 | U508(37),U512(6),TP 501 |
| LEPX1 | Port Expander 1 Enable | U510(6) | 2587 | U511(6) |

**1-8-E-49. Port Expander 0 (U512) Signatures.** Check these signatures if the port expander enable lines signatures were correct. There are two sets of signatures for U512, each using a different clock sense. Table 1-8-E-6 contains the output signatures for U512 and should be checked first. If these signatures are correct, there is no need to check the signatures in Table 1-8-E-7. For a more complete check of U512, proceed with the SA2 procedure. The remaining SA1 signatures are listed in Table 1-8-E-9 and are for the display.

1-8-E-50. To check the U512 signatures, do the following:

a. Check the display to make sure display segments 0 thru 7 are on. This ensures the instrument is running an SA routine. If the display segments are not on, perform the same setup that was explained for the ROM data bus signatures (paragraph 1-8-E-41).

b. Set the signature analyzer as follows:

Start = ⌐_ (in)
Stop = _/⁻ (out)
Clock = _/⁻ (out)

c. Connect the signature analyzer as follows:

Start to J504 ST
Stop to J504 SP
Clock to J503 CLK C

**Table 1-8-E-6. Port Expander 0 (U512) Output Signatures (SA1 Test)**

| +5V Signature: 1H44 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| LPIL | HP-IL Chip Enable | U512(2) | 76HF | U501(28),RP503(1) |
| HEXR | XRAM Enable | U512(3) | P75C | U504(17),U503(17) |
| HECAL | Cal RAM Enable | U512(4) | 0000 (Gnd) | U502(17) |
| HDS2 | Option Data Select | U512(5) | 0000 (Gnd) | J500(12),J501(12), J502(12),RP503(3) |
| -- | A/D Conversion | U512(13) | 0000 (Gnd) | U513(9) |
| -- | A/D Conversion | U512(14) | 0000 (Gnd) | U513(11) |
| -- | A/D Conversion | U512(15) | 0000 (Gnd) | U513(14) |
| -- | A/D Conversion | U512(16) | 0000 (Gnd) | U513(7) |
| -- | A/D Conversion | U512(17) | 0000 (Gnd) | U513(5) |
| -- | A/D Conversion | U512(18) | 0000 (Gnd) | U513(3) |
| DATA | Input Hybrid Configuration | U512(20) | 4576 | U102(26) |
| LBS01 | Used by Option Boards | U512(21) | 1H44 (+5V) | J500(3),RP502(13) |

1-8-E-51. The input signatures to U512 are listed in Table 1-8-E-7 and 1-8-E-8. If these signatures are all correct, but there was one or more incorrect signature from Table 1-8-E-6, replace U512. The signatures in Table 1-8-E-7 are obtained using the rising edge of clock, and the signatures in Table 1-8-E-8 using the falling edge of the clock. To check the signatures in Table 1-8-E-7, do the following:

a. Check the display to make sure display segments 0 thru 7 are on. This ensures the instrument is running an SA routine. If the display segments are not on, perform the same setup that was explained for the ROM data bus signatures (paragraph 1-8-E-41).

b. Set the signature analyzer as follows:

Start = ⎺\⎽ (in)
Stop = ⎽/⎺ (out)
Clock = ⎽/⎺ (out)

c. Connect the signature analyzer as follows:

Start to J504 ST
Stop to J504 SP
Clock to J503 CLK C

**Table 1-8-E-7. Port Expander 0 (U512) Input Signatures Using the Rising Clock Edge (SA1 Test)**

+5V Signature: 1H44

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| LEPXO | Port Expander 0 Enable | U512(6) | 38F3 | U508(37),U510(5)*,TP 501 |
| PROG | Port Expander Direction Control | U512(7) | 0000f | U508(25),J503 CLK C, U511(7) |
| A11 | Addr 11 | U512(8) | HF0A | U508(24),U511(8), U506(18),U505(18),TP 505 |
| A10 | Addr 10 | U512(9) | 2F45 | U508(23),U511(8), U506(19),U505(19),TP 510 |
| A9 | Addr 9 | U512(10) | 136C | U508(22),U511(10), U506(22),U505(2) |
| A8 | Addr 8 | U512(11) | 9UPH | U508(21),U511(11), U506(23),U505(23) |

* This signature does not appear at this location if the motherboard part number is 03421-66501.

1-8-E-52. To check the signatures in Table 1-8-E-8, leave the setup the same as was outlined for the signatures in Table 1-8-E-7, except change the signature analyzer clock sense to the falling edge (Clock = ¯_ (in)).

**Table 1-8-E-8. Port Expander 0 (U512) Input Signatures Using the Falling Clock Edge (SA1 Test)**

+5V Signature: 1H44

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| LEPX0 | Port Expander 0 Enable | U512(6) | 38F3 | U508(37),U510(5)*,TP 501 |
| PROG | Port Expander Direction Control | U512(7) | 1H44f | U508(25),J503 CLK C, U511(7) |
| A11 | Addr 11 | U512(8) | C202 | U508(24),U511(8), U506(18),U505(18),TP 505 |
| A10 | Addr 10 | U512(9) | 4F3U | U508(23),U511(8), U506(19),U505(19),TP 510 |
| A9 | Addr 9 | U512(10) | 045F | U508(22),U511(10), U506(22),U505(2) |
| A8 | Addr 8 | U512(11) | 19C6 | U508(21),U511(11), U506(23),U505(23) |

f indicates that the probe tip is flashing

* This signature does not appear at this location if the motherboard part number is 03421-66501.

**1-8-E-53. Display Signatures.** At power-on, all display segments should turn on for a brief period during self test. If that occurs, and display segments 0, 1, 2, 3, 4, 5, 6, and 7 turn on when the an SA routine is running, then the display and the circuitry that drives the display is operating properly.

1-8-E-54. The display signatures are listed in Table 1-8-E-9. If these signatures are all correct and the display still does not operate properly, either the cable going to the display or the display itself is defective. If an incorrect display signature is found, suspect the device sourcing that signal. For example, if P501 pin 1 has the wrong signature, U508 is probably defective.

1-8-E-55. To check the display signatures, do the following:

a. Check the display to make sure display segments 0 thru 7 are on. This ensures that the instrument is running an SA routine. If the display segments are not on, perform the same setup that was explained for the ROM data bus signatures (paragraph 1-8-E-41).

b. Set the signature analyzer as follows:

Start = ¯_ (in)
Stop = _/¯ (out)
Clock = _/¯ (out)

c. Connect the signature analyzer as follows:

Start to J504 ST
Stop to J504 SP
Clock to J503 CLK C

**Table 1-8-E-9. Display Signature (SA1 Test)**

| +5V Signature: 1H44 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| SD | Serial Data to Display | P501(1) | 6P12 | U508(28),J500(10), J501(10),J502(10) |
| CLK | Display Clock | P501(2) | 0000f | U508(38),J500(11), J501(11),J502(11) |
| LOAD | Loads Display | P501(3) | 0040* | U511(20) |
| GND | Ground | P501(5) | 0000(Gnd) | -- |
| +5V | +5V | P501(6) | 1H44(+5V) | -- |
| f indicates the probe tip should be flashing | | | | |
| * if this signature is incorrect, run SA2 to check U511 | | | | |

1-8-E-56. This completes the SA1 Test. If you need to verify the operation of U501, U511, or further verify that U512 is operating properly, proceed with the SA2 Test.

## 1-8-E-57. SA2 Test

1-8-E-58. SA2 allows you to verify the signatures for the following circuitry:

Port Expanders (U512,U511)
HP-IL Chip (U501)
Cal RAM (U502)

1-8-E-59. You should check the SA2 signatures in the order given. It is important to understand that if Cal RAM (U502) is tested, the calibration constants will be altered, and will require an instrument re-calibration. Because of this, the setup to test Cal RAM is explained independent of the other SA2 test segments. If you want to test only Cal RAM, go directly to paragraph 1-8-E-64.

**NOTE**

*The HP 3421A should be re-calibrated, after running the SA2 Test.*

1-8-E-60. To run the SA2 test (except for the Cal RAM portion), do the following:

a. Make sure all segments of the rear panel switch (S501) are in the up position.

b. Connect TP 509 (U508 pin 1) to ground. Early instruments do not have TP 509, in which case you should connect U508 pin 1 to ground.

c. Make sure E501 is in place.

d. Set the signature analyzer as follows:

Start = (in)
Stop = (out)
Clock = (out)

e. Connect the signature analyzer as follows:

Start to J504 ST
Stop to J504 SP
Clock to J503 CLK C

f. Make sure that the instrument is disconnected from HP-IL.

g. If the motherboard part number is 03421-66501, move switch segment 4 of switch S501 to the down position. If the motherboard part number is 03421-66511, move switch segment 1 of S501 to the down position.

h. Cycle power by pressing the front panel switch off and then on.

i. If the motherboard part number is 03421-66501, move switch segment 4 of switch S501 to the up position. If the motherboard part number is 03421-66511, move switch segment 1 of S501 to the up position.

j. Move switch segment 6 of switch S501 to the down position.

k. Assuming that the display is operating properly, display segments 0, 1, 2, 3, 4, 5, 6, and 7 should be on. This ensures the instrument is running an SA routine. If these display segments are not on, repeat this setup. If these display segments still do not turn on after repeating the setup, there may be a problem with the display, display connector, or the circuitry that drives the display. See paragraph 1-8-E-53.

l. Check the +5V signature which should be U9FF. If it is wrong, perform steps a through k again.

**1-8-E-61. Port Expander (U511,U512) Signatures.** After completing the setup you are ready to check the signatures for port expander 0 (U512) and port expander 1 (U511). Check the ouputs listed in Table 1-8-E-10 and 1-8-E-11 first. If the outputs are correct, there is no need to check the inputs.

**Table 1-8-E-10. Port Expander 0 (U512) Output Signatures (SA2 Test)**

+5V Signature: U9FF

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| LPIL | HP-IL Chip Enable | U512(2) | 0003 | U501(28),RP503(1) |
| HEXR | XRAM Enable | U512(3) | 0002 | U503(17),U504(17) |
| HECAL | Cal RAM Enable | U512(4) | 0003 | U502(17) |
| HDS2 | Option Card Data | U512(5) | 0002 | J500(12),J501(12), J502(12),RP503(3) |
| -- | Used By A/D Section | U512(13) | U82U | U513(9) |
| -- | Used By A/D Section | U512(14) | U82U | U513(11) |
| -- | Used By A/D Section | U512(15) | U82U | U513(14) |
| -- | Used By A/D Section | U512(16) | U82U | U513(7) |
| -- | Used By A/D Section | U512(17) | U93H | U513(5) |
| -- | Used By A/D Section | U512(18) | U93H | U513(3) |
| MODE | Configururation Line For Input Hybrid | U512(19) | U93H | U102(24) |
| DATA | Configuration Line For Input Hybrid | U512(20) | U93H | U102(26) |
| LBS01 | Used By Option Card | U512(21) | U9C4 | J500(3),RP502(13) |
| LLB | Low Battery Detect | U512(22) | U9C4 | U700(2) |
| SA2 | Signature Analysis Test Test 2 | U512(23 | U9C4* | RP502(9) |

* Switch segment 6 of S501 must be in the up position to obtain this signature. If it is down, the signature should be 0000.

Table 1-8-E-11. Port Expander 1 (U511) Output Signatures (SA2 Test)

+5V Signature: U9FF

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| LBS11 | Used By Option Cards | U511(1) | 8106 | J501(3),RP502(3) |
| DIO | Used By Option Cards | U511(2) | F5A9 | J500(4) |
| DI1 | Used By Option Cards | U511(3) | F5A9 | J501(4) |
| DI2 | Used By Option Cards | U511(4) | F5A9 | J502(4) |
| LBSO2 | Used By Option Cards | U511(5) | F5A9 | J500(2),RP502(12) |
| B1 | Used By Option Cards | U511(13) | 1AP4 | J501(9),RP503(9) |
| A2 | Used By Option Cards | U511(14) | 1AP4 | J502(8),RP503(13) |
| B2 | Used By Option Cards | U511(15) | 1AP4 | J502(9),RP503(12) |
| DOE | Used By Option Cards | U511(16) | 1AP4 | J500(1),J501(1), J502(1),RP503(2) |
| A1 | Used By Option Cards | U511(17) | 0858 | J501(8),RP503(8) |
| BO | Used By Option Cards | U511(18) | 0858 | J500(9),RP503(11) |
| AO | Used By Option Cards | U511(19) | 0858 | J500(8),RP503(10) |
| LOAD | Loads Display | U511(20) | 0858 | P501(3),RP503(4) |
| LBS22 | Used By Option Cards | U511(21) | 8106 | J502(2),RP502(2) |
| LBS21 | Used By Option Cards | U511(22) | 8106 | J502(3).RP502(1) |
| LBS12 | Used By Option Cards | U511(23) | 8106 | J501(2),RP502(10) |

1-8-E-62. If all of the port expander output signatures were correct in Tables 1-8-E-10 and 1-8-E-11, there is no need to check the port expander input signatures. Instead, refer to paragraph 1-8-E-63 and check the HP-IL loop. The port expander input signatures are listed in Tables 1-8-E-12 and 1-8-E-13. To check these signatures, do the following:

a. Perform the same setup that was outlined at the beginning of the SA2 Test, except change the signature analyzer clock sense to Clock = ⌝_ (in).

**Table 1-8-E-12. Port Expander 0 (U512) Input Signatures (SA2 Test)**

+5V Signature: U9FF

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| LEPX0 | Port Expander 0 Enable | U512(6) | UA35 | U508(37),U510(5)*, TP 501 |
| PROG | Port Expander Direction Control | U512(7) | U9FFf | U508(25),U511(7) J503 CLK C |
| A11 | Addr 11 | U512(8) | 0000f | U508(24),U506(18), U505(18),U511(8), TP 505 |
| A10 | Addr 10 | U512(9) | U9FFf | U508(23),U506(19), U505(19),U511(9), TP 510 |
| A9 | Addr 9 | U512(10) | 34U3 | U508(22),U506(22), U505(22),U511(10) |
| A8 | Addr 8 | U512(11) | AP8A | U508(21),U506(23), U505(23),U511(11) |

f indicates that the probe tip should be flashing

* This signature does not appear at this location if the motherboard part number is 03421-66501.

**Table 1-8-E-13. Port Expander 1 (U511) Input Signatures (SA2 Test)**

+5V Signature: U9FF

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| LEPX1 | Port Expander 1 Enable | U511(6) | 03U9f | U510(6)* |
| PROG | Port Expander Direction Control | U511(7) | U9FFf | U508(25),U512(7) J503 CLK C |
| A11 | Addr 11 | U511(8) | 0000f | U508(24),U506(18), U505(18),U512(8), TP 505 |
| A10 | Addr 10 | U511(9) | U9FFf | U508(23),U506(19), U505(19),U512(9), TP 510 |
| A9 | Addr 9 | U511(10) | 34U3 | U508(22),U506(22), U505(22),U512(10) |
| A8 | Addr 8 | U511(11) | AP8A | U508(21),U506(23), U505(23),U512(11) |

f indicates that the probe tip should be flashing

* This signature does not appear at this location if the motherboard part number is 03421-66501.

**1-8-E-63. HP-IL Loop.** Perform this portion of the SA2 Test if you are have having I/O problems. To run this portion of the test, do the following:

a. Make sure all segments of the rear panel switch (S501) are in the up position.

b. Connect an HP-IL cable between the rear panel HP-IL input and output connectors.

c. Connect TP509 (U508 pin 1) to ground. Early instruments do not have TP509, in which case you should connect U508 pin 1 to ground.

d. Make sure E501 is in place.

e. Press the front panel switch on.

f. Set the signature analyzer as follows:

Start = (in)
Stop = (out)
Clock = (in)

g. Connect the signature analyzer as follows:

Start to J504 ST
Stop to J504 SP
Clock to J503 CLK A

h. If the motherboard part number is 03421-66501, move switch segment 4 of S501 to the down position. If the motherboard part number is 03421-66511, move switch segment 1 of S501 to the down position.

i. Cycle power by pressing the front panel switch off and then on.

j. If the motherboard part number is 03421-66501, move swith segment 4 of S501 back to the up position. If the motherboard part number is 03421-66511, move switch segment 1 of S501 back to the up postion.

k. Move switch segment 6 of S501 to the down position.

l. Check the +5V signature. If it is F2HA, then the HP-IL loop circuitry is operating properly. If the +5V signature is wrong, first make sure the HP-IL cable is connected between the rear panel HP-IL input and output connectors. If the cable is connected properly, the problem could be U501, the HP-IL transformer, or some component associated with the HP-IL input or output. To isolate the problem, perform the following steps:

1. Set a dual trace oscilloscope to 5 μs/div, 2V/div vertical gain and check U501 pin 17 and U501 pin 18 for the waveforms shown in Figure 1-8-E-11A or Figure 1-8-E-11B. Use Figure 1-8-E-11A if the motherboard part number is 03421-66501. Use Figure 1-8-E-11B if the motherboard part number is 03421-66511. To obtain the wavforms shown, channel B of the oscilloscope must be inverted. Also reference the oscilloscope probes to instrument ground. If the waveforms are correct but you are having an I/O problem, U501 is probably defective. If the waveforms are wrong or non-existent, proceed with step 2.

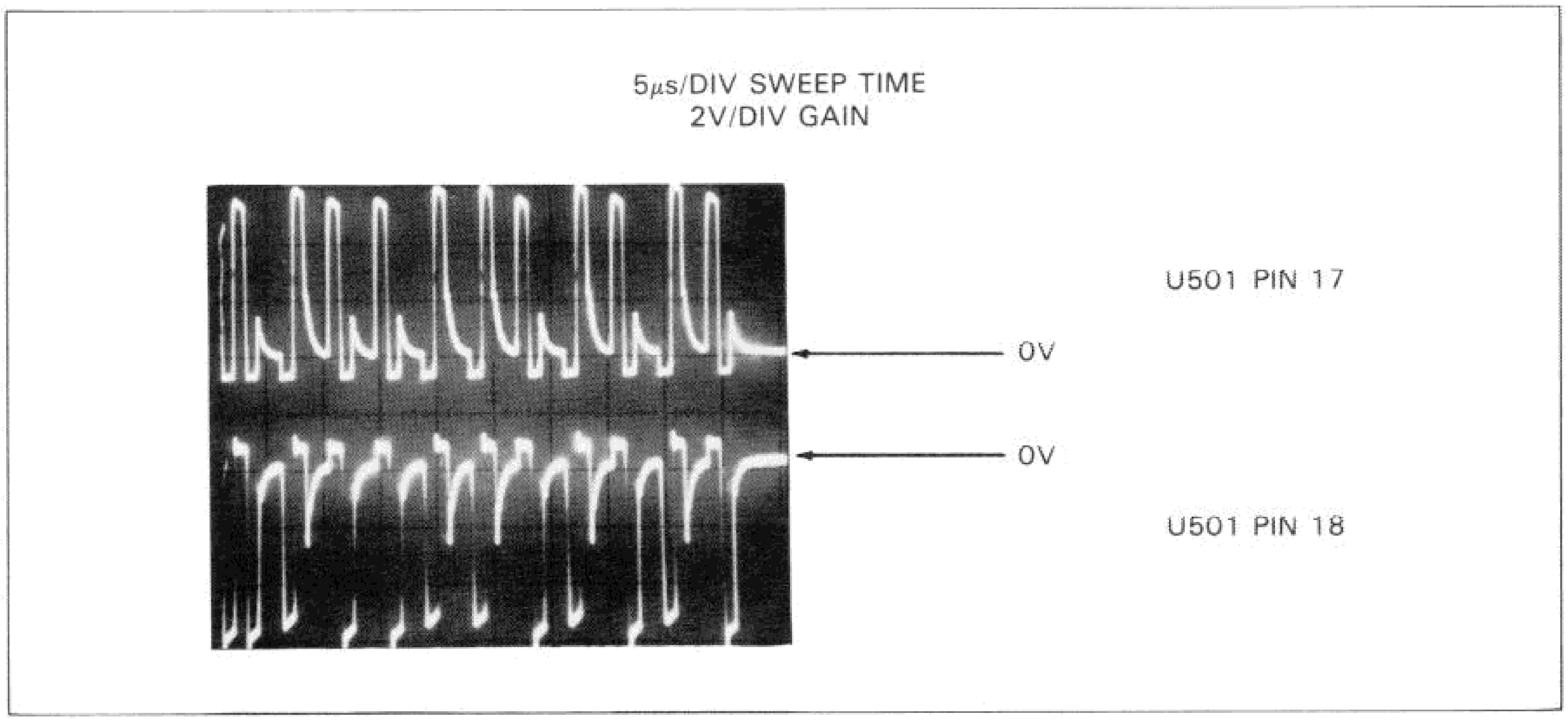



**Figure 1-8-E-11A. Waveforms at U501 (17,18) for 03421-66501 Motherboard (SA2 Test)**

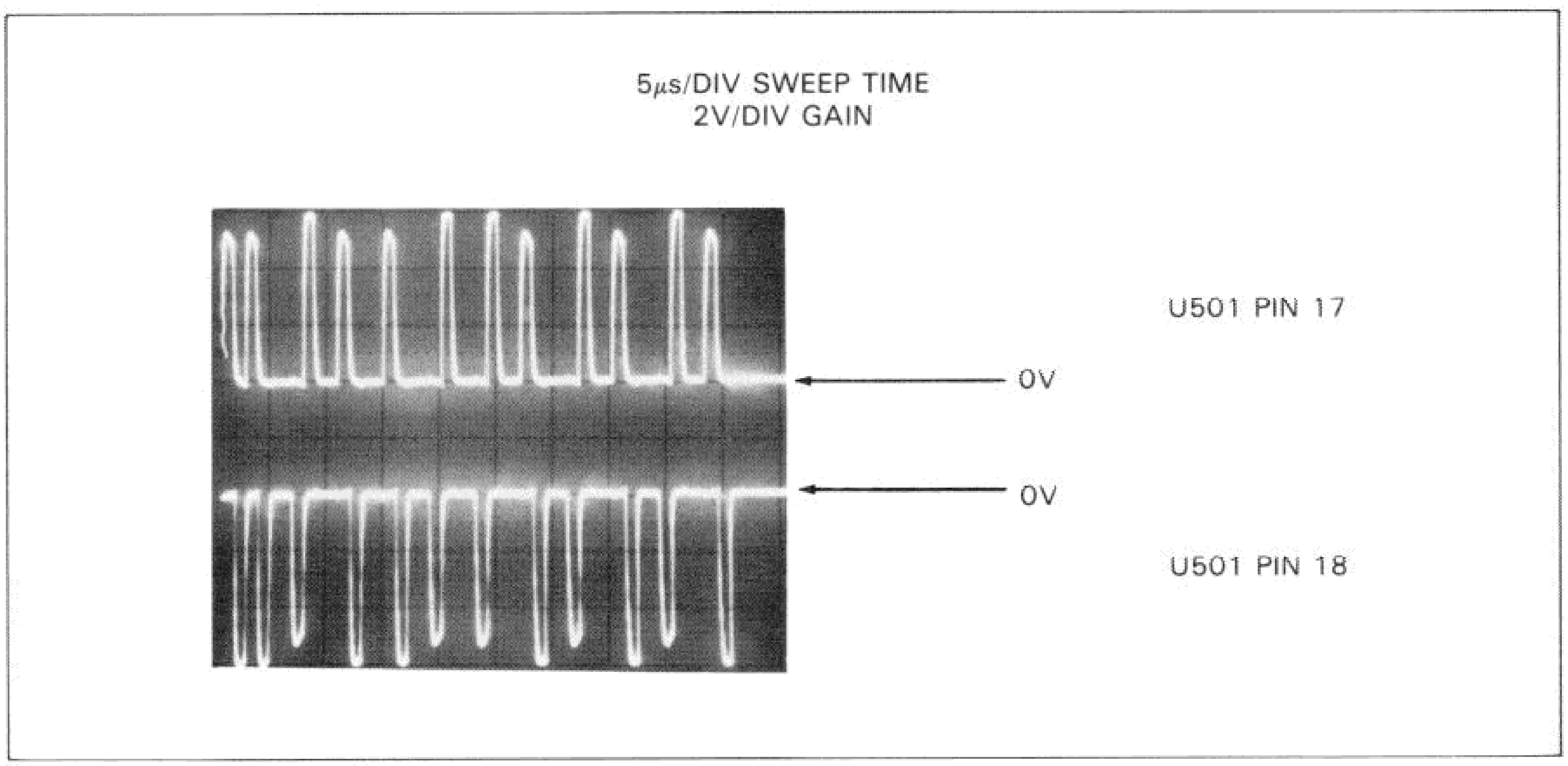



**Figure 1-8-E-11B. Waveforms at U501(17,18) for 03421-66511 Motherboard (SA2 Test)**

2. Check U501 pin 19 and U501 pin 20 for the waveforms shown in Figure 1-8-E-12A or Figure 1-8-E-12B. Use Figure 1-8-E-12A if the motherboard part number is 03421-66501. Use Figure 1-8-E-12B if the motherboard part number is 03421-66511. If the waveforms are incorrect or non-existent, the problem could be U501 or T501. In early instruments (03421-66501 motherboard) this circuitry was configured differently (see schematic in Section VII). If the waveforms are correct, suspect a problem with either the HP-IL cable or T501. Use an ohmmeter and check continuity of the cable and the primary and secondary windings of T501 (early instruments also had a T502; see schematic in Section VII). On the loop side of the transformers, check continuity of T501 between J505 pins 3 and 4, and between J505 pins 1 and 2. Check continuity on the other side of the transformer between U501 pin 19 and 20 and between the emitters of Q505 and Q506.

5μs/DIV SWEEP TIME
2V/DIV GAIN

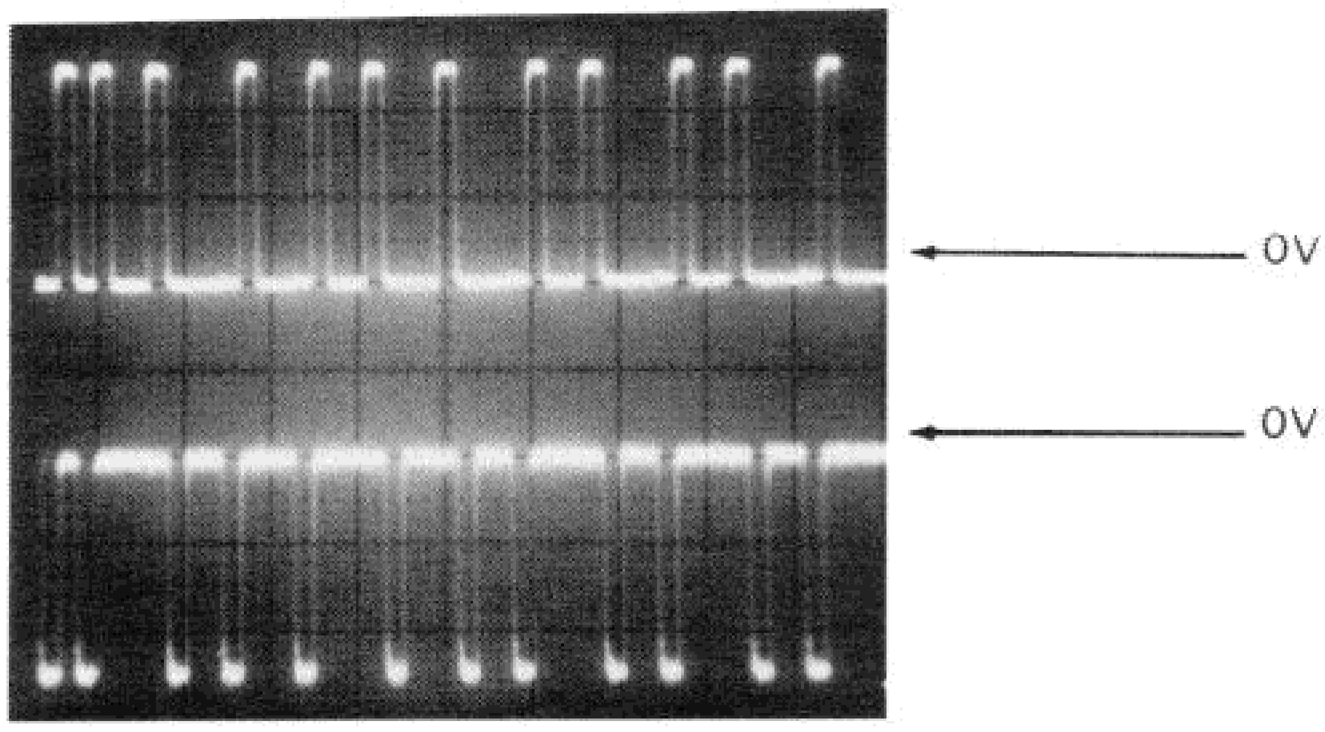



**Figure 1-8-E-12A. Waveforms at U501 pins 19 and 20 for 03421-66501 Motherboard (SA2 Test)**

5μs/DIV SWEEP TIME
2V/DIV GAIN

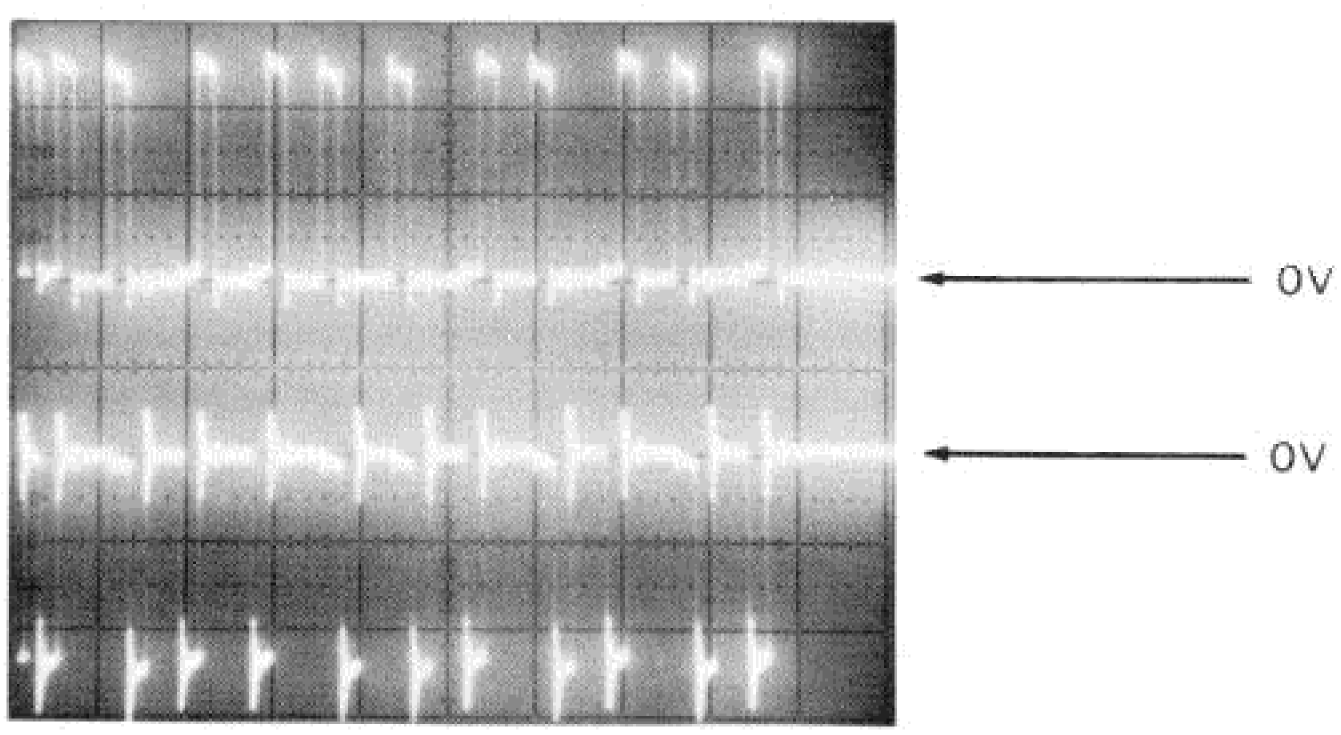



**Figure 1-8-E-12B. Waveforms at U501 pin 19 and 20 for 03421-66511 Motherboard (SA2 Test)**

3. If the continuity checks are all OK, and there still is not a waveform at U501 pins 17 and 18, check CR501, CR502, R503, R504, Q503, and Q504. In early instruments, there are some additional components associated with the HP-IL circuitry which could be failing (see schematic in Section VII). If all of the HP-IL components are OK, replace U501.

**1-8-E-64. Calibration RAM (U502) Signatures.** If you run this portion of the SA2 Test, all calibration constants will be cleared, and the instrument must be re-calibrated. Therefore, do not run this portion of the SA2 Test unless you suspect a Cal RAM failure. Cal RAM failures are usually detected during self test. However, there is a possibility that a Cal RAM failure will not be detected during self test. A Cal RAM failure symptom that might not be detected during self test is erroneous readings that occur after the instrument has been calibrated for a particular function and/or range. To check the Cal RAM signatures, do the following:

**NOTE**

*The HP 3421A should be re-calibrated, after running the SA2 Test.*

a. Perform the same setup that was outlined at the beginning of the SA2 Test, except connect the clock to TP 508. Make sure the clock sense is Clock = (out).

**NOTE**

*When you perform step b, the Cal RAM contents will be cleared and the instrument must be re-calibrated.*

b. Move switch segment 8 of S501 to the down position.

c. Make sure the HP-IL cable is not connected to I/O connectors on the rear panel.

d. Check the Cal RAM signatures listed in Table 1-8-E-14.

**Table 1-8-E-14. Cal RAM (U502) Signatures (SA2 Test)**

| +5V Signature: 8C2F | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| D0 | Data Bit 0 | U502(9,10) | 3018 | U508(12),U507(18), E501(3,14),U506(9), U505(9),U504(9,10), U501(14) |
| D1 | Data Bit 1 | U502(11,12) | UPA2 | U508(13),U507(17), E501(4,13),U506(10), U505(10),U504(11,12), U501(13) |
| D2 | Data Bit 2 | U502(13,14) | UPA2 | U508(14),U507(14), E501(7,10),U506(11), U505(11),U504(13,14), U501(12) |
| D3 | Data Bit 3 | U502(15,16) | UPA2 | U508(15),U507(13), E501(8,9),U506(13), U505(13),U504(15,16), U501(11) |

**1-8-E-65. Freerun Test**

1-8-E-66. The Freerun Test is recommended to isolate defective components that cause data bus information to be incorrect. Eight sets of data bus signatures must be checked to completely verify that the data bus information is correct. The various signature sets are selected by connecting TP 502, TP 503, and TP 505 to either ground or +5V. The configuration for each of the eight signature sets is explained in the procedures.

1-8-E-67. Check the signatures in the order given, starting with the eight sets of data bus signatures. Signature sets 0, 1, 2, and 3 verify that U506 is providing good data. Signature sets 4, 5, 6, and 7 verify that U505 is providing good data. If all of the data bus signature sets check OK, there is no need to proceed further with the Freerun Test. If any signature is incorrect, proceed with the checks as directed and verify the address and enable lines signatures.

**1-8-E-68. Signature Set 0.** Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Press the HP 3421A front panel switch off.

b. Remove bus break E501.

c. Set the signature analyzer as follows:

Start = (in)
Stop = (in)
Clock = (out)

d. Connect the signature analyzer as follows:

Start to TP 510 (early instruments do not have TP 510, in which case you should use U506 pin 19)
Stop to TP 510
Clock to TP 506

e. Connect TP 502, TP 503, and TP 505 to ground.

f. Press the HP 3421A front panel switch on.

g. Refer to Table 1-8-E-15 and check signature set 0. If any signature is incorrect, proceed to paragraph 1-8-E-76.

**1-8-E-69. Signature Set 1.** Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Use the same setup that was used for signature set 0, except configure the three test points as follows:

TP 503 to ground
TP 502 to ground
TP 505 to +5V

b. Check the signatures listed in Table 1-8-E-16. If any signature is incorrect, proceed with paragraph 1-8-E-76.

## Table 1-8-E-15. Data Bus Signature Set 0 (Freerun Test)

TP 503, TP 502, and TP 505 all grounded.

+5V Signature: 7A70

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U506(9) | C5P7 | U505(9),U504(9,10), U502(9,10),U501(14) |
| D1 | Data Bit 1 | U506(10) | H4P3 | U505(10),U504(11,12), U502(11,12),U501(13) |
| D2 | Data Bit 2 | U506(11) | U57F | U505(11),U504(13,14), U502(13,14),U501(12) |
| D3 | Data Bit 3 | U506(13) | 6CC9 | U505(13),U504(15,16), U502(15,16),U501(11) |
| D4 | Data Bit 4 | U506(14) | 618C | U505(14),U503(9,10), U501(9) |
| D5 | Data Bit 5 | U506(15) | 9U84 | U505(15),U503(11,12), U501(8) |
| D6 | Data Bit 6 | U506(16) | C6AC | U505(16),U503(13,14), U501(7) |
| D7 | Data Bit 7 | U506(17) | U9FC | U505(17),U503(15,16), U501(6) |

## Table 1-8-E-16. Data Bus Signature Set 1 (Freerun Test)

TP 503 and TP 502 grounded
TP 505 to +5V

+5V Signature: 7A70

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U506(9) | U244 | U505(9),U504(9,10), U502(9,10),U501(14) |
| D1 | Data Bit 1 | U506(10) | 60H2 | U505(10),U504(11,12), U502(11,12),U501(13) |
| D2 | Data Bit 2 | U506(11) | A672 | U505(11),U504(13,14), U502(13,14),U501(12) |
| D3 | Data Bit 3 | U506(13) | CHUH | U505(13),U504(15,16), U502(15,16),U501(11) |
| D4 | Data Bit 4 | U506(14) | 968U | U505(14),U503(9,10), U501(9) |
| D5 | Data Bit 5 | U506(15) | 74UH | U505(15),U503(11,12), U501(8) |
| D6 | Data Bit 6 | U506(16) | 853H | U505(16),U503(13,14), U501(7) |
| D7 | Data Bit 7 | U506(17) | CUP9 | U505(17),U503(15,16), U501(6) |

**1-8-E-70. Signature Set 2.** Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Use the same setup that was used for signature set 0, except configure the three test points as follows:

TP 503 to ground
TP 502 to +5V
TP 505 to ground

b. Check the signatures listed in Table 1-8-E-17. If any signature is incorrect, proceed with paragraph 1-8-E-76.

**Table 1-8-E-17. Data Bus Signature Set 2 (Freerun Test)**

TP 503 to ground
TP 502 to +5V
TP 505 to ground

+5V Signature: 7A70

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U506(9) | 6C85 | U505(9),U504(9,10), U502(9,10),U501(14) |
| D1 | Data Bit 1 | U506(10) | C21F | U505(10),U504(11,12), U502(11,12),U501(13) |
| D2 | Data Bit 2 | U506(11) | 0A0P | U505(11),U504(13,14), U502(13,14),U501(12) |
| D3 | Data Bit 3 | U506(13) | U8A9 | U505(13),U504(15,16), U502(15,16),U501(11) |
| D4 | Data Bit 4 | U506(14) | AHAC | U505(14),U503(9,10), U501(9) |
| D5 | Data Bit 5 | U506(15) | H5U1 | U505(15),U503(11,12), U501(8) |
| D6 | Data Bit 6 | U506(16) | 9724 | U505(16),U503(13,14), U501(7) |
| D7 | Data Bit 7 | U506(17) | C903 | U505(17),U503(15,16), U501(6) |

**1-8-E-71. Signature Set 3.** Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Use the same setup that was used for signature set 0, except configure the three test points as follows:

TP 503 to ground
TP 502 to +5V
TP 505 to +5V

b. Check the signatures listed in Table 1-8-E-18. If any signature is incorrect, proceed with paragraph 1-8-E-76.

**Table 1-8-E-18. Data Bus Signature Set 3 (Freerun Test)**

TP 503 to ground
TP 502 to +5V
TP 505 to +5V

+5V Signature: 7A70

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U506(9) | 1730 | U505(9),U504(9,10), U502(9,10),U501(14) |
| D1 | Data Bit 1 | U506(10) | 0C62 | U505(10),U504(11,12), U502(11,12),U501(13) |
| D2 | Data Bit 2 | U506(11) | PAH1 | U505(11),U504(13,14), U502(13,14),U501(12) |
| D3 | Data Bit 3 | U506(13) | C44U | U505(13),U504(15,16), U502(15,16),U501(11) |
| D4 | Data Bit 4 | U506(14) | UC5H | U505(14),U503(9,10), U501(9) |
| D5 | Data Bit 5 | U506(15) | 181F | U505(15),U503(11,12), U501(8) |
| D6 | Data Bit 6 | U506(16) | 112C | U505(16),U503(13,14), U501(7) |
| D7 | Data Bit 7 | U506(17) | 7577 | U505(17),U503(15,16), U501(6) |

**1-8-E-72. Signature Set 4.** Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Use the same setup that was used for signature set 0, except configure the three test points as follows:

TP 503 to +5V
TP 502 to ground
TP 505 to ground

b. Check the signatures listed in Table 1-8-E-19. If any signature is incorrect, proceed with paragraph 1-8-E-76.

**Table 1-8-E-19. Data Bus Signature Set 4 (Freerun Test)**

TP 503 to +5V
TP 502 to ground
TP 505 to ground

+5V Signature: 7A70

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U505(9) | 28FA | U506(9),U504(9,10), U502(9,10),U501(14) |
| D1 | Data Bit 1 | U505(10) | 933P | U506(10),U504(11,12), U502(11,12),U501(13) |
| D2 | Data Bit 2 | U505(11) | 1FAA | U506(11),U504(13,14), U502(13,14),U501(12) |
| D3 | Data Bit 3 | U505(13) | P9C8 | U506(13),U504(15,16), U502(15,16),U501(11) |
| D4 | Data Bit 4 | U505(14) | 840C | U506(14),U503(9,10), U501(9) |
| D5 | Data Bit 5 | U505(15) | 7025 | U506(15),U503(11,12), U501(8) |
| D6 | Data Bit 6 | U505(16) | 709F | U506(16),U503(13,14), U501(7) |
| D7 | Data Bit 7 | U505(17) | 2U80 | U506(17),U503(15,16), U501(6) |

**1-8-E-73. Signature Set 5.** Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Use the same setup that was used for signature set 0, except configure the three test points as follows:

TP 503 to +5V
TP 502 to ground
TP 505 to +5V

b. Check the signatures listed in Table 1-8-E-20. If any signature is incorrect, proceed with paragraph 1-8-E-76.

**Table 1-8-E-20 Data Bus Signature Set 5 (Freerun Test)**

TP 503 to +5V
TP 502 to ground
TP 505 to +5V

+5V Signature: 7A70

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U505(9) | 8UA7 | U506(9),U504(9,10), U502(9,10),U501(14) |
| D1 | Data Bit 1 | U505(10) | 73HF | U506(10),U504(11,12), U502(11,12),U501(13) |
| D2 | Data Bit 2 | U505(11) | A6P3 | U506(11),U504(13,14), U502(13,14),U501(12) |
| D3 | Data Bit 3 | U505(13) | 2537 | U506(13),U504(15,16), U502(15,16),U501(11) |
| D4 | Data Bit 4 | U505(14) | 2750 | U506(14),U503(9,10), U501(9) |
| D5 | Data Bit 5 | U505(15) | UC35 | U506(15),U503(11,12), U501(8) |
| D6 | Data Bit 6 | U505(16) | 5A8U | U506(16),U503(13,14), U501(7) |
| D7 | Data Bit 7 | U505(17) | 4885 | U506(17),U503(15,16), U501(6) |

**1-8-E-74. Signature Set 6.** Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Use the same setup that was used for signature set 0, except configure the three test points as follows:

TP 503 to +5V
TP 502 to +5V
TP 505 to ground

b. Check the signatures listed in Table 1-8-E-21. If any signature is incorrect, proceed with paragraph 1-8-E-76.

**Table 1-8-E-21. Data Bus Signature Set 6 (Freerun Test)**

TP 503 to +5V
TP 502 to +5V
TP 505 to ground

+5V Signature: 7A70

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U505(9) | 533H | U506(9),U504(9,10), U502(9,10),U501(14) |
| D1 | Data Bit 1 | U505(10) | 0PA5 | U506(10),U504(11,12), U502(11,12),U501(13) |
| D2 | Data Bit 2 | U505(11) | 5AP2 | U506(11),U504(13,14), U502(13,14),U501(12) |
| D3 | Data Bit 3 | U505(13) | 584H | U506(13),U504(15,16), U502(15,16),U501(11) |
| D4 | Data Bit 4 | U505(14) | U7P2 | U506(14),U503(9,10), U501(9) |
| D5 | Data Bit 5 | U505(15) | 42U8 | U506(15),U503(11,12), U501(8) |
| D6 | Data Bit 6 | U505(16) | 0AH1 | U506(16),U503(13,14), U501(7) |
| D7 | Data Bit 7 | U505(17) | U9A6 | U506(17),U503(15,16), U501(6) |

**1-8-E-75. Signature Set 7.** Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Use the same setup that was used for signature set 0, except configure the three test points as follows:

TP 503 to +5V
TP 502 to +5V
TP 505 to +5V

b. Check the signatures listed in Table 1-8-E-22. If any signature is incorrect, proceed with paragraph 1-8-E-76.

**Table 1-8-E-22. Data Bus Signature Set 7 (Freerun Test)**

TP 503 to +5V
TP 502 to +5V
TP 505 to +5V

+5V Signature: 7A70

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit 0 | U505(9) | 263C | U506(9),U504(9,10), U502(9,10),U501(14) |
| D1 | Data Bit 1 | U505(10) | 8P07 | U506(10),U504(11,12), U502(11,12),U501(13) |
| D2 | Data Bit 2 | U505(11) | F735 | U506(11),U504(13,14), U502(13,14),U501(12) |
| D3 | Data Bit 3 | U505(13) | 8PHU | U506(13),U504(15,16), U502(15,16),U501(11) |
| D4 | Data Bit 4 | U505(14) | 4F23 | U506(14),U503(9,10), U501(9) |
| D5 | Data Bit 5 | U505(15) | 4955 | U506(15),U503(11,12), U501(8) |
| D6 | Data Bit 6 | U505(16) | A76U | U506(16),U503(13,14), U501(7) |
| D7 | Data Bit 7 | U505(17) | 21HC | U506(17),U503(15,16), U501(6) |

**1-8-E-76. CPU Address/Data Bus Signatures.** Check these signatures if a bad signature was found in any of the eight data bus signature sets. Although these lines are labeled as D0-D7, the signatures will actually be address signatures since the bus break has been removed. If an incorrect CPU signature is found, replace U508. If these CPU signatures are correct, proceed to paragraph 1-8-E-78.

1-8-E-77. Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Make sure bus break E501 is removed.

b. Set the signature analyzer as follows:

Start = ↘ (in)
Stop = ↘ (in)
Clock = ↘ (in)

c. Connect the signature analyzer as follows:

Start to TP 510 (early instruments do not have TP 510, in which case you should use U506 pin 19)
Stop to TP 510
Clock to J503 Clk A

d. Connect TP 502, TP 503, and TP 505 to ground.

e. Refer to Table 1-8-E-23 and check the D0-D7 CPU signatures. If any signature is incorrect, replace U508. If all signatures are correct, proceed with paragraph 1-8-E-78.

**Table 1-8-E-23. CPU D0-D7 Signatures (Freerun Test)**

TP 503, TP 502, and TP 505 all grounded

+5V Signature: 7A70

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Addr Bit 0 | U508(12) | H62U | U507(18),RP501(3) |
| D1 | Addr Bit 1 | U508(13) | C21A | U507(17),RP501(4) |
| D2 | Addr Bit 2 | U508(14) | HA07 | U507(14),RP501(7) |
| D3 | Addr Bit 3 | U508(15) | H0AA | U507(13),RP501(8) |
| D4 | Addr Bit 4 | U508(16) | P030 | U507(8),RP501(6) |
| D5 | Addr Bit 5 | U508(17) | 4442 | U507(7),RP501(5) |
| D6 | Addr Bit 6 | U508(18) | 4U2A | U507(3),RP501(1) |
| D7 | Addr Bit 7 | U508(19) | 0772 | U507(4),RP501(2) |

**1-8-E-78. Remaining CPU Address Signatures.** These signatures consist of A8 through A12, and PT25. If A8, A9, or A10 has the wrong signature, U508 is probably bad. If A11, A12, or A13 has the wrong signature, your setup is wrong. If all the signatures are correct, proceed to paragraph 1-8-E-80.

1-8-E-79. Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Make sure bus break E501 is removed.

b. Set the signature analyzer as follows:

Start = ⎺\⎽ (in)
Stop = ⎺\⎽ (in)
Clock = ⎺\⎽ (in)

c. Connect the signature analyzer as follows:

Start to TP 510 (early instruments do not have TP 510, in which case you should use U506 pin 19)
Stop to TP 510
Clock to TP 506

d. Connect TP 502, TP 503, and TP 505 to ground.

e. Refer to Table 1-8-E-24 and check the CPU signatures for A1-8-A12 and PT25. If any signature is incorrect, U508 is probably bad. If all signatures are correct, proceed with paragraph 1-8-E-80.

**Table 1-8-E-24. CPU Upper Address Signatures (Freerun Test)**

| +5V Signature: 7A70 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| A8 | Addr Bit 8 | U508(21) | 9635 | U506(23),U505(23), U512(11),U511(11) |
| A9 | Addr Bit 9 | U508(22) | 1734 | U506(22),U505(22), U512(10),U511(11) |
| A10 | Addr Bit 10 | U508(23) | 8P54 | U506(19),U505(19), U512(9),U511(9), TP 510 |
| A11 | Addr Bit 11 | U508(24) | 0000(GND) | U506(18),U505(18), U512(8),U511(8), TP 505 |
| A12 | Addr Bit 12 | U508(35) | 0000(GND) | U506(21),U505(21), TP 502 |
| PT25 | P/O ROM Enable | U508(36) | 0000(GND) | U509(4,5,12),TP 503 |

**1-8-E-80. Address Latch Signatures.** Check these signatures if the CPU address signatures (lines labeled D0-D7 with the bus break removed) were correct. If any signature is incorrect, U507 is probably bad, although it could be any device that shares the address line with the incorrect signature. If all signatures are correct, but there was one or more incorrect ROM data bus signatures, either ROM U505 or U506 is bad, or there is a problem with the ROM enable circuitry (U509 or U508).

1-8-E-81. Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Make sure bus break E501 is removed.

b. Set the signature analyzer as follows:

Start = ⎺\⎽ (in)
Stop = ⎺\⎽ (in)
Clock = ⎺\⎽ (in)

c. Connect the signature analyzer as follows:

Start to TP 510 (early instruments do not have TP 510, in which case you should use U506 pin 19)
Stop to TP 510
Clock to TP 506

d. Connect TP 502, TP 503, and TP 505 to ground.

e. Refer to Table 1-8-E-25 and check the address signatures at the output of the U507 address latch. If all signatures are correct, but there was a bad data bus signature, U505 or U506 is probably bad. If any signature is incorrect, suspect U507, although it could be any device sharing that bus line.

**Table 1-8-E-25. Address Bus Signatures (Freerun Test)**

| +5V Signature: 7A70 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| A0 | Addr Bit 0 | U507(19) | H62U | U506(8),U505(8), U504(4),U503(4), U502(4),U501(5) |
| A1 | Addr Bit 1 | U507(16) | C21A | U506(7),U505(7), U504(3),U503(3), U502(3),U501(4) |
| A2 | Addr Bit 2 | U507(15) | HA07 | U506(6),U505(6), U504(2),U503(2), U502(2),U501(3) |
| A3 | Addr Bit 3 | U507(12) | H0AA | U506(5),U505(5), U504(1),U503(1), U502(2) |
| A4 | Addr Bit 4 | U507(9) | P030 | U506(4),U505(4), U504(21),U503(21), U502(21) |
| A5 | Addr Bit 5 | U507(6) | 4442 | U506(3),U505(3), U504(5),U503(5), U502(5) |
| A6 | Addr Bit 6 | U507(2) | 4U2A | U506(2),U505(2), U504(6),U503(6), U502(6) |
| A7 | Addr Bit 7 | U507(5) | 0772 | U506(1),U505(1), U504(7),U503(7), U502(7) |

1-8-E-81. Refer to the flowchart of Figure 1-8-E-13 and do the following:

a. Make sure bus break E501 is removed.

b. Set the signature analyzer as follows:

Start = $\searrow$ (in)
Stop = $\searrow$ (in)
Clock = $\searrow$ (in)

c. Connect the signature analyzer as follows:

Start to TP 510 (early instruments do not have TP 510, in which case you should use U506 pin 19)
Stop to TP 510
Clock to TP 506

d. Connect TP 502, TP 503, and TP 505 to ground.

e. Refer to Table 1-8-E-25 and check the address signatures at the output of the U507 address latch. If all signatures are correct, but there was a bad data bus signature, U505 or U506 is probably bad. If any signature is incorrect, suspect U507, although it could be any device sharing that bus line.

**Table 1-8-E-25. Address Bus Signatures (Freerun Test)**

| +5V Signature: 7A70 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| A0 | Addr Bit 0 | U507(19) | H62U | U506(8),U505(8), U504(4),U503(4), U502(4),U501(5) |
| A1 | Addr Bit 1 | U507(16) | C21A | U506(7),U505(7), U504(3),U503(3), U502(3),U501(4) |
| A2 | Addr Bit 2 | U507(15) | HA07 | U506(6),U505(6), U504(2),U503(2), U502(2),U501(3) |
| A3 | Addr Bit 3 | U507(12) | H0AA | U506(5),U505(5), U504(1),U503(1), U502(2) |
| A4 | Addr Bit 4 | U507(9) | P030 | U506(4),U505(4), U504(21),U503(21), U502(21) |
| A5 | Addr Bit 5 | U507(6) | 4442 | U506(3),U505(3), U504(5),U503(5), U502(5) |
| A6 | Addr Bit 6 | U507(2) | 4U2A | U506(2),U505(2), U504(6),U503(6), U502(6) |
| A7 | Addr Bit 7 | U507(5) | 0772 | U506(1),U505(1), U504(7),U503(7), U502(7) |

**1-8-E-82. ROM Enable Circuitry Signatures.** These signatures should be checked if there were incorrect data bus signatures, but all other signatures in the Freerun Test were correct. To completely verify proper operation of this circuitry, two different setups are required.

1-8-E-83. Refer to the flowchart in Figure 1-8-E-13 and do the following:

a. Make sure bus break E501 is removed.

b. Set the signature analyzer as follows:

Start = ⏷ (in)
Stop = ⏷ (in)
Clock = ⏷ (in)

c. Connect the signature analyzer as follows:

Start to TP 510 (early instruments do not have TP 510, in which case you should use U506 pin 19)
Stop to TP 510
Clock to TP 506

d. Connect TP 502, TP 503, and TP 505 to ground. With this setup, U506 is outputting data.

e. Check the signatures in Table 1-8-E-26. If they are correct, proceed to paragraph 1-8-E-84 and check the same circuit nodes with the modified setup. If either signature is incorrect, make sure TP 503 (U508 pin 26) is grounded and that TP 506 (U508 pin 9) is making transitions. If TP 503 and TP 506 are OK, then replace U509. If they are not OK, replace U508.

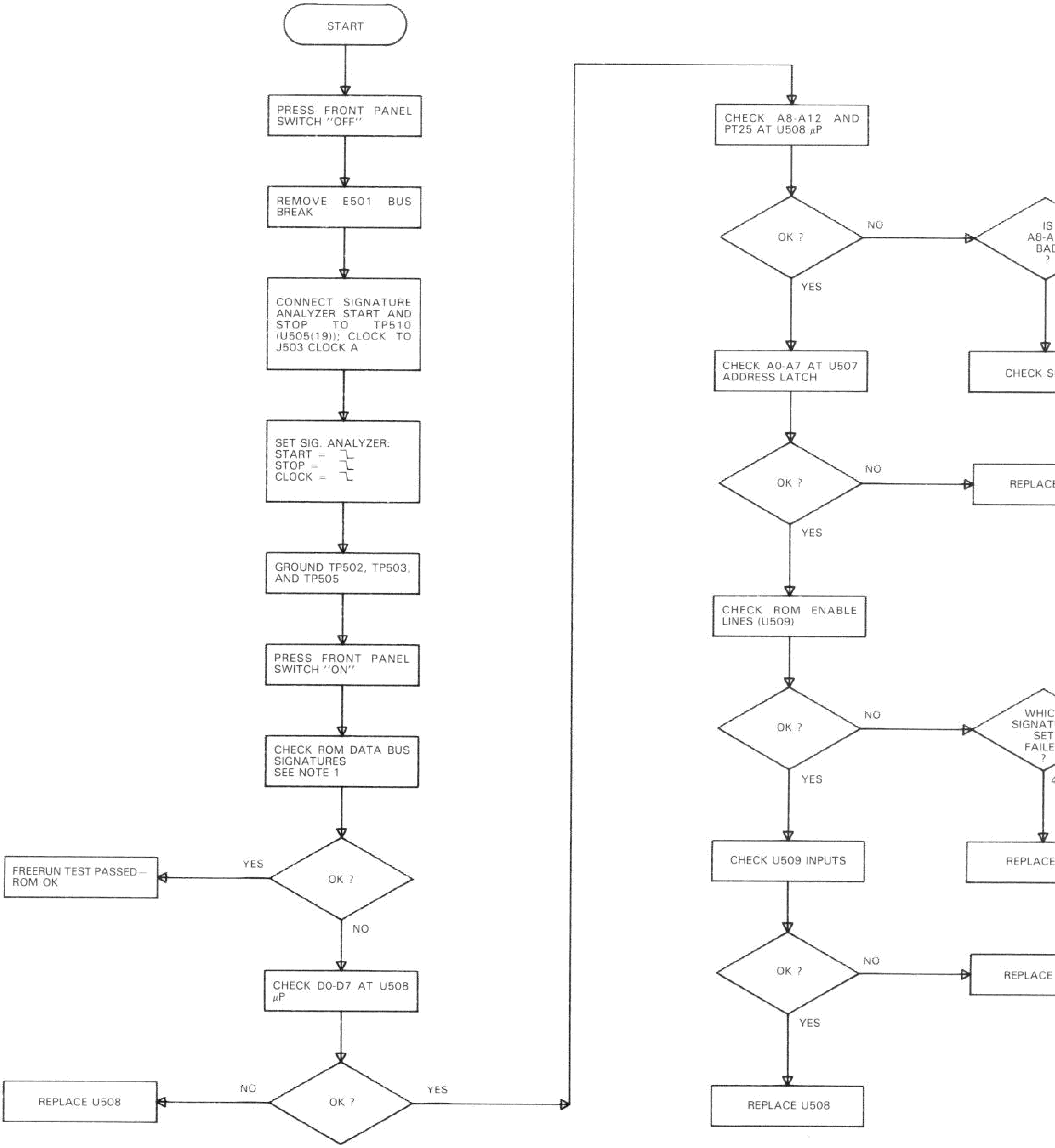
**Table 1-8-E-26. ROM Enable Signatures (Freerun Test)**

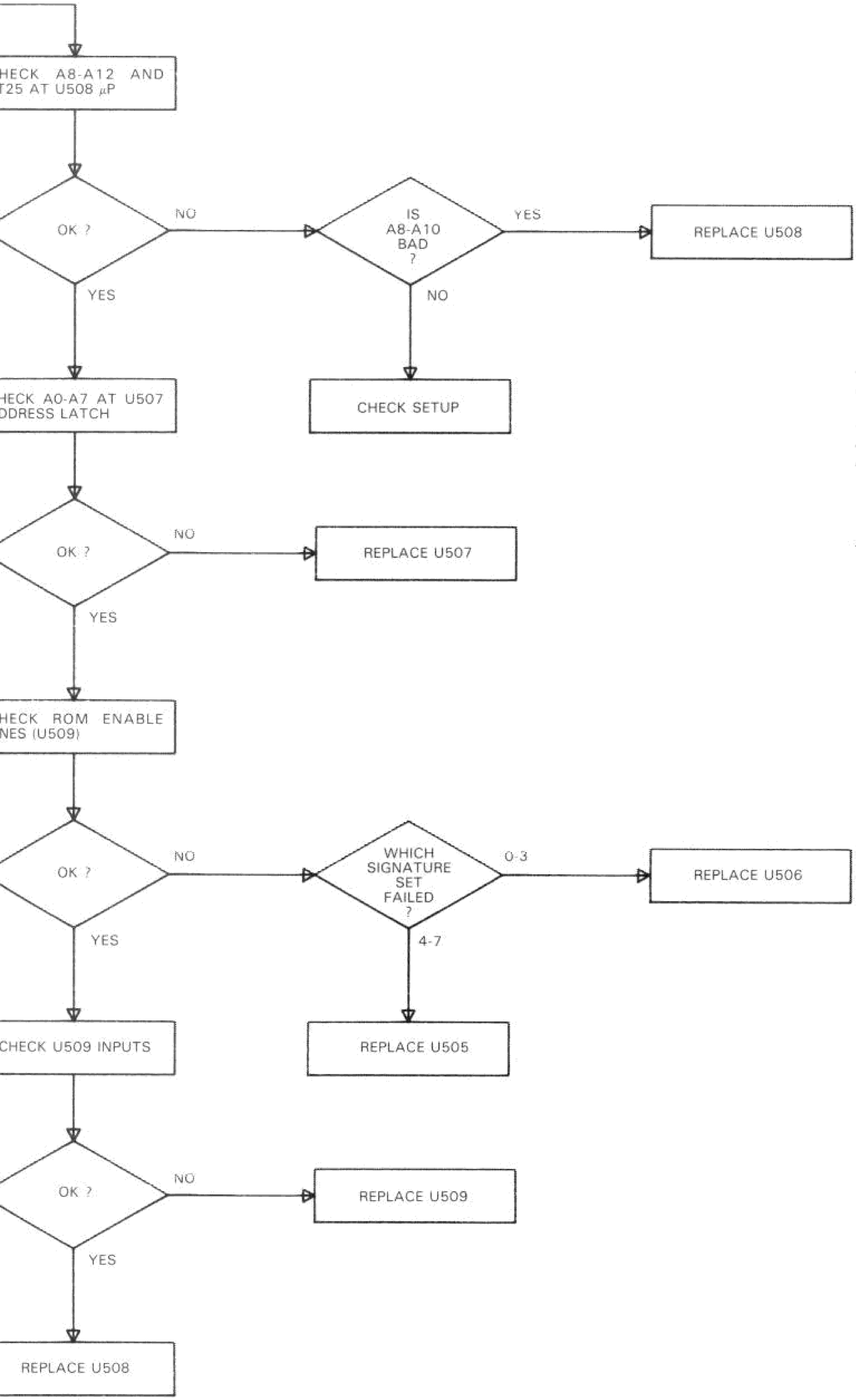
| TP 502, TP503 and TP 505 Grounded<br>+5V Signature: 7A70 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| LEROM0 | ROM 0 Enable | U509(3) | 7A70f | U506(20) |
| LEROM1 | ROM 1 Enable | U509(11) | 7A70(+5V) | U505(20) |
| f indicates that the probe tip should be flashing | | | | |

1-8-E-84. For the second set of signatures for U509, perform the same setup that was explained for the signatures in Table 1-8-E-26, except connect TP 503 to +5V. With this setup, U505 is outputting data. Refer to Table 1-8-E-27 for the signatures.

**Table 1-8-E-27. ROM Enable Signatures (Freerun Test)**

| TP 502 and TP 505 Grounded; TP 503 to +5V<br>+5V Signature: 7A70 | | | | |
|---|---|---|---|---|
| **Mnemonic** | **Function** | **Check At** | **Signature** | **Also Appears At** |
| LEROM0 | ROM 0 Enable | U509(3) | 7A70(+5V) | U506(20) |
| LEROM1 | ROM 1 Enable | U509(11) | 7A70f | U505(20) |
| f indicates that the probe tip should be flashing | | | | |


START
PRESS FRONT PANEL SWITCH "OFF"
REMOVE E501 BUS BREAK
CONNECT SIGNATURE ANALYZER START AND STOP TO TP510 (U505(19)); CLOCK TO J503 CLOCK A
SET SIG. ANALYZER:
START =
STOP =
CLOCK =
GROUND TP502, TP503, AND TP505
PRESS FRONT PANEL SWITCH "ON"
CHECK ROM DATA BUS SIGNATURES SEE NOTE 1
OK ?
YES
FREERUN TEST PASSED — ROM OK
NO
CHECK D0-D7 AT U508 μP
OK ?
NO
REPLACE U508
YES
CHECK A8-A12 AND PT25 AT U508 μP
OK ?
NO
YES
CHECK A0-A7 AT U507 ADDRESS LATCH
OK ?
NO
YES
CHECK ROM ENABLE LINES (U509)
OK ?
NO
YES
CHECK U509 INPUTS
OK ?
NO
YES
REPLACE U508




**NOTE**

*There are eight sets of ROM Data Bus Signatures associated with the Freerun Test. A signature set is selected by TP502, TP503, and TP505. For the first set, these TP's are all grounded. For the second set TP505 is connected to +5V. To check all eight sets, use the binary progression outlined below. NOTE: 0 = Gnd; 1 = +5V.*

| Signature Set | TP503 | TP502 | TP505 | Used To Check ROM |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | U506 |
| 1 | 0 | 0 | 1 | U506 |
| 2 | 0 | 1 | 0 | U506 |
| 3 | 0 | 1 | 1 | U506 |
| 4 | 1 | 0 | 0 | U505 |
| 5 | 1 | 0 | 1 | U505 |
| 6 | 1 | 1 | 0 | U505 |
| 7 | 1 | 1 | 1 | U505 |

Figure 1-8-E-13. Freerun Test Flowchart

# SERVICE GROUP F
# REFERENCE
# AND
# POWER SUPPLY TROUBLESHOOTING

**Service Group F Contents**



**CAUTION**

*The instrument contains CMOS Integrated Circuits which are susceptible to damage from static discharge. It is important that grounded tools and wrist straps be used when handling or troubleshooting these components.*

## 1-8-F-1. INTRODUCTION

1-8-F-2. This service group contains the troubleshooting procedures for the reference supplies (+10V, −10V, and buffered −10V), VB, VBATT, +5V, +15V, and −15V. This service group also contains information to troubleshoot the Low Power Up (LPU), Low Power Down (LPD), and Low Low Battery (LLB) circuitry. As additional troubleshooting information, a table of typical power supply currents is provided (see paragraph 1-8-F-64).

1-8-F-3. As noted in the previous paragraph, the HP 3421A uses several different power supply voltages. Two of these voltages, VB and VBATT, could be a source of confusion unless their generation and use are understood.

1-8-F-4. VB and VBATT are essentially the same voltage in that they are both generated from the main battery, or the ac line when the instrument is plugged into an ac outlet. The only difference between the two voltages is that VBATT is unswitched, while VB is switched. That is, VBATT should always appear at the TP VBATT, and at all other circuit locations where it is used, regardless of the set/reset state of the K700 relay. The only time VBATT is removed from the instrument circuitry is when the rear panel Reset pushbutton is held in. VB, however, is applied to the various circuit locations only when the front panel switch is on and the rear panel pushbutton is out. VB is also removed when a loop power down is in effect. If the front panel switch is off or the rear panel pushbutton is in, VB is removed from all circuit locations, including TP VB.

1-8-F-5. VBATT, the unswitched voltage, appears at the circuit locations where power is required for the instrument to power up when the front panel switch is pressed on, or for the instrument to "wakeup" from a loop power down. VBATT is also used by the XRAM battery backup circuit. VB, the switched voltage, appears at the circuit locations where the battery voltage is required during normal instrument operation.

## 1-8-F-6. EQUIPMENT REQUIRED

1-8-F-7. The following equipment is required to perform the troubleshooting procedures in this service group.

High Impedance Digital Voltmeter (like the HP 3456A)
Oscilloscope
Current Meter (optional - used to measure power supply currents)

## 1-8-F-8. REFERENCE SUPPLY TROUBLESHOOTING

1-8-F-9. The reference supplies consist of the −10V, −10V buffered, and +10V. These supplies, and where they are checked, are listed in Table 1-8-F-1. First check the −10V and −10V buffered references, since these are used to generate the +10V reference. The reference supplies can be found on schematic 1.

**Table 1-8-F-1. Reference Supply Voltages**

| Reference Supply | Check At | Tolerance |
|---|---|---|
| −10V Reference | TP 400 | ±.5V |
| −10V Buffered | U404 pin 6 | ±.5V |
| +10V Reference | TP 401 | ±.5V |

1-8-F-10. If the −10V reference voltage is incorrect, refer to paragraph 1-8-F-11 for troubleshooting. If the −10V buffered voltage is incorrect, refer to paragraph 1-8-F-13 for troubleshooting. If the +10V reference voltage is incorrect, refer to paragraph 1-8-F-15 for troubleshooting.

### 1-8-F-11. −10V Reference Troubleshooting

1-8-F-12. To troubleshoot the −10V reference, perform the following procedure.

a. Measure pin 1 of CR401 for a stable −6.9V (approximately). Pins 2 and 3 of CR401 should be at ground. If pin 1 of CR401 is correct, proceed with step b. If it is wrong, do the following:

1. Check the −15V supply at TP −15V to be sure it is correct (−15V (±.25V)). If it is wrong, refer to paragraph 1-8-F-37 for troubleshooting.

2. If the −15V supply is correct, make sure R439 is good. If R439 is good, replace CR401.

3. If the −15V supply and R439 are good, replace U403.

b. Check U405 pin 2 for approximately −6.9V. If it is incorrect, replace U405.

c. If the −10V reference is still incorrect, replace U404. If that does not solve the problem, replace U403.

### 1-8-F-13. −10V Buffered Reference Troubleshooting

1-8-F-14. To troubleshoot the −10V buffered reference, do the following:

a. First make sure that the −10V reference voltage is correct (see paragraph 1-8-F-11). If the −10V reference is OK, proceed with step b.

b. Unsolder and lift one end of R408.

c. Check U404 pin 6 for −10V. If it is correct, replace U403. If it is incorrect, replace U404.

d. Resolder R408.

### 1-8-F-15. +10V Reference Troubleshooting

1-8-F-16. If the +10V reference voltage is incorrect, do the following:

a. First make sure that the −10V reference (TP 400) and the −10V buffered reference (U404 pin 6) are correct. Both should have a value of −10V (±.5V). The troubleshooting procedures for these references were explained starting with paragraph 1-8-F-8.

b. Unsolder and lift one end of JM201, and check the +10V reference again at TP 401. If it is now correct, replace U102 and then resolder JM201. If it is still incorrect, proceed with step c.

c. Replace U402. If the +10V reference is still incorrect, replace U403.

d. Resolder JM201.

## 1-8-F-17. BATTERY BACKUP/CAL RAM BATTERY BACKUP TROUBLESHOOTING

1-8-F-18. The HP 3421A has a 6V main battery (BT701) and a 3V Cal RAM battery (BT501). The main battery allows portable operation of the instrument, and provides power to the XRAM during a loop power down or when the front panel switch is off. BT701 is rechargeable and charges automatically when the HP 3421A is plugged into an appropriate ac outlet. The Cal RAM battery maintains power to the Cal RAM (U502) when the front panel switch is off (or the rear panel pushbutton is in), or when a loop power down is in effect. BT501 is not rechargeable, but has an approximate life of 5 years.

1-8-F-19. The troubleshooting procedures for these two backup circuits are explained in the following paragraphs.

### 1-8-F-20. Battery Backup Circuitry Troubleshooting

1-8-F-21. This circuitry consists of Q502, Q503, and associated components. Its purpose is to maintain power to the XRAM (U503 and U504) during a loop power down, or when the front panel switch is pressed off. Before troubleshooting this circuitry, refer to schematic 3 and note that VBATT is an unswitched voltage (i.e., it always appears at TP VBATT, even if the front panel switch is pressed off). This means that Q503 will always have the main battery voltage applied to it. To troubleshoot this circuitry, perform the following procedure.

a. Check TP VBATT for a voltage of 5.8V to 7.6V. If it is incorrect, refer to the battery charger circuitry troubleshooting (paragraph 1-8-F-28). If it is correct, proceed with step b.

b. With the front panel switch off, check the base and emitter voltages of Q503. The exact voltages measured will depend upon the amount of charge held by the main battery. For example, if the main battery voltage is exactly 7V, you can expect the Q503 emitter to read about 3.8V and the base to read about 4.2V.

c. Press the front panel power switch on.

d. The emitter of Q503 should now go to about 5V. The base will be lower than the emitter, which means that Q503 is turned off. If the emitter does not go to 5V, check TP +5V and TP +15V to make sure these two supplies are correct. If these supplies are correct, replace Q502. If they are incorrect, the +5V and +15V troubleshooting procedures can be found starting with paragraph 1-8-F-35 and paragraph 1-8-F-37, respectively.

### 1-8-F-22. Cal RAM Battery Backup Circuitry Troubleshooting

**IMPORTANT**

*If power to the Cal RAM is disrupted while you are troubleshooting this circuitry, all instrument functions must be re-calibrated.*

1-8-F-23. This circuitry consists of Q501, BT501, and associated circuitry. Its purpose is to allow BT501 to supply power to the Cal RAM when power is pressed off or a loop power down occurs. This maintains the calibration constants stored in the Cal RAM, regardless of the power state of the instrument. To troubleshoot this circuitry, do the following:

a. With the front panel switch off, check the voltage at the cathode of CR506 (or U502 pin 22), which should read about 2.8V, depending upon the charge held by BT501. The minimum voltage at the cathode of CR506 should be no less than 2V.

b. If the CR506 cathode voltage is incorrect, proceed with step c. If the CR506 cathode voltage is correct, do the following:

1. Press the front panel power switch on and check the cathode of CR506, which should go to about 5V. If it does, the Cal RAM battery backup circuit is operating properly.

2. If the cathode of CR506 does not go to +5V when the power switch is pressed on, check the +15V and +5V supplies (TP +15V and TP +5V). If they are correct, replace Q501. If they are incorrect, the troubleshooting procedure for the +5V and +15V supplies can be found starting with paragraph 1-8-F-35 and paragraph 1-8-F-37, respectively.

c. With the front panel switch off, check the positive side of BT501 for a minimum of 2.4V. If it is incorrect, replace BT501. If it is correct, replace CR506.

d. If, after replacing either BT501 or CR506, the cathode of CR506 still has the wrong voltage, replace the Cal RAM (U502).

e. After obtaining the proper voltage at the cathode of CR506 with the front panel switch off, make sure Q501 is operating properly. This can be done by pressing the front panel switch on and checking that the Q501 emitter goes to +5V.

## 1-8-F-24. VB AND VBATT CIRCUITRY TROUBLESHOOTING

1-8-F-25. As explained in paragraph 1-8-F-4, the only difference between these two voltages is that VB is switched and VBATT is unswitched. The troubleshooting procedures for both voltages is explained in the following paragraphs.

### 1-8-F-26. VBATT Circuitry Troubleshooting

1-8-F-27. To troubleshooting this circuitry, do the following:

a. Unplug the instrument from the ac power source.

b. Check TP VBATT for a voltage between 5.8V and 7.6V. If it is correct, VBATT is OK. If it is incorrect, proceed with step c.

c. Plug the instrument into an appropriate ac line source. The front panel switch may be either on or off.

d. With the instrument plugged into the ac line, again check TP VBATT for a voltage between 5.8V and 7.6V. If VBATT is now correct, either there is an open in one of the battery leads or the battery is depleted. Do the following:

1. Make sure the 2A fuse (F700) is good.

2. Check the connectors that plug onto both battery terminals for an open.

3. If steps 1 and 2 check good, the battery is most likely depleted. Check the battery directly across the battery terminals for a voltage of 5.8V to 7.6V. It should be noted that a low battery will take several hours to charge. Also, a completely depleted battery will not hold any charge until it has been re-charged for about two hours.

e. If VBATT is low when the instrument is plugged into the ac line, check for an open between one of the battery terminals and TP VBATT. Also check the 2A fuse (F700) to make sure it is good.

f. Check the positive lead of the main battery for a voltage of 5.8V to 7.6V. If the voltage is 0V, make sure the 2A fuse (F700) is good. If the voltage is low (but not 0V), the battery charger circuit is defective, in which case you should go to paragraph 1-8-F-28 for troubleshooting.

### 1-8-F-28. Battery Charger Circuitry Troubleshooting

1-8-F-29. This circuitry consists of Q700, Q701, U702A, U702B, RT700, CR704, and associated components. The purpose of this circuitry is to supply charge current for the main battery and current for the remainder of the instrument.

1-8-F-30. Before troubleshooting the battery charger circuitry, it would be a good idea to consider the various component functions. These are as follows:

U702A – Voltage Regulator for the battery float voltage
(Float voltage is the voltage that the battery is being charged to. The float voltage appears at the cathode of CR704).

U702B – Current Regulator that limits current from transformer T700.

Q700 – Pass Transistor.

Q701 – Drive Transistor.

RT700 – Thermistor with a negative temperature coefficient that changes float voltage with temperature (i.e., when temperature goes up, float voltage goes down).

CR704 – Diode which acts as an open switch to keep the battery from discharging through the charger circuitry when the power cord is unplugged.

1-8-F-31. A failure in this circuitry can exhibit one of the following problems: F701 (.15A) blows when the power cord is plugged into an ac outlet; main battery will not charge; main battery will not hold a charge when the instrument is powered down. If F700 (2A fuse) keeps blowing, probably the only thing in the battery charger circuit that could cause this is a short across R706, R707, and R708 (or RT700), a short across CR717, or some other multiple component failure which would allow the positive side of the battery to have a low impedance path to ground. If F701 (.15A) is blowing, the most likely cause is some circuit component(s) in the instrument (and probably in the battery charger circuitry) is drawing too much current. The troubleshooting procedures for the symptoms of the battery charger circuit failures are explained in the following paragraphs.

**1-8-F-32. F701 Blows With AC Power Applied.** Since this type of failure will not permit the ac line cord to be plugged into an ac outlet without blowing the fuse, do the following:

a. First check the bridge rectifier diodes (CR700 - CR703).

b. If the bridge rectifier is OK, check the TP REF for 1.235V ($\pm$ 10mV). If it is incorrect, replace U703.

c. If TP REF is OK, check transistors Q700 and Q701.

d. If Q700 and Q701 are OK, check for a short across R705.

e. If R705 is OK, replace U702.

**1-8-F-33. Main Battery Will Not Charge.** Before troubleshooting the battery charger circuitry for this type of failure, understand that a discharged battery ($<$5.8V and $>$1V) can take up to 16 hours to fully charge. A completely discharged battery ($<$1V) could take up to 48 hours to charge. Also be aware that if the ac line fuse (the rear panel fuse F701) is open or the battery fuse (F700) is open, the battery will not charge. If the battery has been given ample time to charge and the fuses are good, but the battery still does not charge, do the following:

a. Disconnect the main battery from the instrument circuitry by removing the main battery fuse (F700). Do not mistake this fuse with the ac line fuse. F700 is the 2A normal blow fuse located in the fuse holder at the right rear of the instrument as viewed from the front.

b. With F700 removed, check TP 700 for a raw dc voltage of 11.5V to 18V. If it is correct, proceed with step c. If it is incorrect, check the bridge rectifier diodes (CR700 thru CR703), transistors Q700 and Q701, and filter capacitor C700. If these are OK, replace U702.

c. With F700 removed, check the cathode of CR704 for a voltage of 6.9V to 7.6V. If it is correct, proceed with step d. If it is incorrect, first check CR704 to make sure it is not open. If CR704 is OK, check Q700 and Q701. If Q700 and Q701 are OK, replace U702.

d. Check TP REF for a voltage of 1.235V ($\pm$ 10mV). If it is incorrect, replace U703. If this does not solve the problem, check C707.

e. Replace F700.

**1-8-F-34. Battery Discharges When Instrument Is Off.** This type of failure can be caused by a defective battery, defective diodes (CR704 or CR717), or by a defective component that uses VBATT. VBATT is the unswitched battery voltage. That is, it appears at some places in the instrument regardless of set/reset state of relay K700. CR704 acts as an open switch when the ac line cord is removed to keep battery from being discharged to ground. If the battery discharges while the instrument is powered down, do the following:

a. Check CR704 and CR717.

b. Check all components that use VBATT (Q503, U531, U532, and Q531 (Q531 is on instruments that have the 03421-66501 motherboard only)).

c. If all components are OK and the battery charger circuitry is operating properly, the battery is defective. It should be noted that the battery will not sustain repeated discharging to the point where it has little or no charge. If the main battery has been completely discharged four times or more, it is probably defective. Normally, this will not occur because the instrument is designed to power down when a low battery is detected.

## 1-8-F-35. +5V POWER SUPPLY TROUBLESHOOTING

1-8-F-36. The +5V power supply consists of U700C, U700D, Q702, Q703, CR716, and associated components. The +5V supply is used by the control logic and the A/D sections. The U508 CPU will not be able to operate if the +5V supply drops below 4.7V. To troubleshoot the +5V power supply, do the following:

a. Check TP +5V for +5V (±.25V). If it is correct, the +5V power supply is operating properly. If it is incorrect, proceed with step b.

b. Check TP +15V for 15V (±.4V). If it is correct, proceed with step c. If it is incorrect, refer to paragraph 1-8-F-37 for troubleshooting.

c. Check TP VB for a voltage of 5.8V to 7.6V. If it is correct, proceed with step d. If it is incorrect, do the following:

1. Check TP VBATT for a voltage of 5.8V to 7.6V. If TP VBATT is OK, then there is a problem with either the K700 relay, the circuitry that generates Low Power UP (LPU) or Low Power Down (LPD), or the +15V power supply.

2. If TP VBATT is incorrect, there is most likely a problem with the battery charger circuitry. See paragraph 1-8-F-28 for troubleshooting.

d. Lift one end of JM102 and check TP +5V again. If +5V is still incorrect, proceed with step e. If +5V is now OK, some device in the A/D section is drawing too much current from the +5V supply. To troubleshoot this circuitry, replace JM102, refer to schematic 1, and use a high resolution digital voltmeter (like the HP 3456A) to probe the +5V power supply connections of all devices that use +5V in the A/D section. The device drawing excessive current will have the largest voltage drop at its +5V connection(s).

e. Use a cliplead jumper and connect TP LPD to TP VBATT.

f. Lift one end of JM703 and check TP +5V again. If +5V is still incorrect, there is a problem in the +5V regulation circuitry, in which case you should proceed with step g. If, however, +5V is now good, some device in the control logic is drawing too much current. To find the problem, replace JM703, refer to schematic 2, and use a high resolution digital voltmeter (like the HP 3456A) to probe the +5V power supply connections of all devices in the control logic section. The device drawing excessive current will have the largest voltage drop at its +5V connection(s).

g. Replace JM102 and JM703.

h. Check CR716, Q702, and Q703. If these are OK, replace U700.

## 1-8-F-37. +15V AND -15V POWER SUPPLY TROUBLESHOOTING

1-8-F-38. The +15V and −15V are generated by a switching regulator type power supply, which consists of transistors Q704 and Q705, transformer T701, rectifying diodes CR711 and CR712, zener diodes CR714 and CR715, and other associated components.

1-8-F-39. Before troubleshooting these supplies, you should have an understanding of their interaction with one another. The −15V supply regulates the +15V supply. This means that the +15V supply voltage will follow the −15V supply voltage (i.e., if −15V goes low, +15V also goes low). However, as more current is drawn from the +15V supply, it will not alter the −15V supply unless the current draw is excessive. Also, both supplies are generated by the main battery voltage VB. The troubleshooting procedures for these two supplies are explained in the following paragraphs.

### 1-8-F-40. +15V Power Supply Troubleshooting

1-8-F-41. To troubleshoot the +15V supply, do the following:

a. Check TP +15V for a voltage of +15V (±.4V). If it is correct, the +15V supply is operating properly. If it is incorrect, proceed with step b.

b. Check TP −15V for a voltage of −15V (±.25V). If it is incorrect, check TP VB for a voltage of 5.8V to 7.6V. If TP VB is wrong, the problem is most likely in the battery charger circuitry, in which case you should go to paragraph 1-8-F-28 for troubleshooting. If TP −15V is incorrect but TP VB is correct, the problem is with the −15V supply, in which case you should go to paragraph 1-8-F-42 for troubleshooting. If TP −15V is correct, the problem is with the +15V supply, in which case you should do the following:

1. Unsolder and lift one end of JM701.

2. Check TP +15V again. If it is still incorrect, proceed with step c. If TP +15V is now correct, some device in the A/D or control logic section is drawing too much current. In the A/D section, +15V is used by several devices (see the power supply table on schematic 1). In the control logic section, +15V is used by Q501, Q502, and also appears at pin 13 of J500, J501, and J502. To find out which device is drawing excessive current, perform steps 3 and 4.

3. Check Q501 and Q502. If these are OK, proceed with step 4.

4. Using a high resolution digital voltmeter (like the HP 3456A), check the +15V power supply connections of the various ICs in the A/D section. The faulty IC will have the largest voltage drop at its +15V connection. Refer to the power supply configuration table for schematic 1 to identify the pin numbers of the ICs that use the +15V supply.

c. Check zener diode CR714, and capacitors C710 and C713. If these are OK, proceed with step d.

d. Using an oscilloscope set to a sweep time of 20 μs/div and a vertical gain of 10V/div, check the anode of CR712 for the waveform shown in Figure 1-8-F-1. If it is incorrect, first make sure CR712 is OK. If CR712 is good, replace transformer T701.

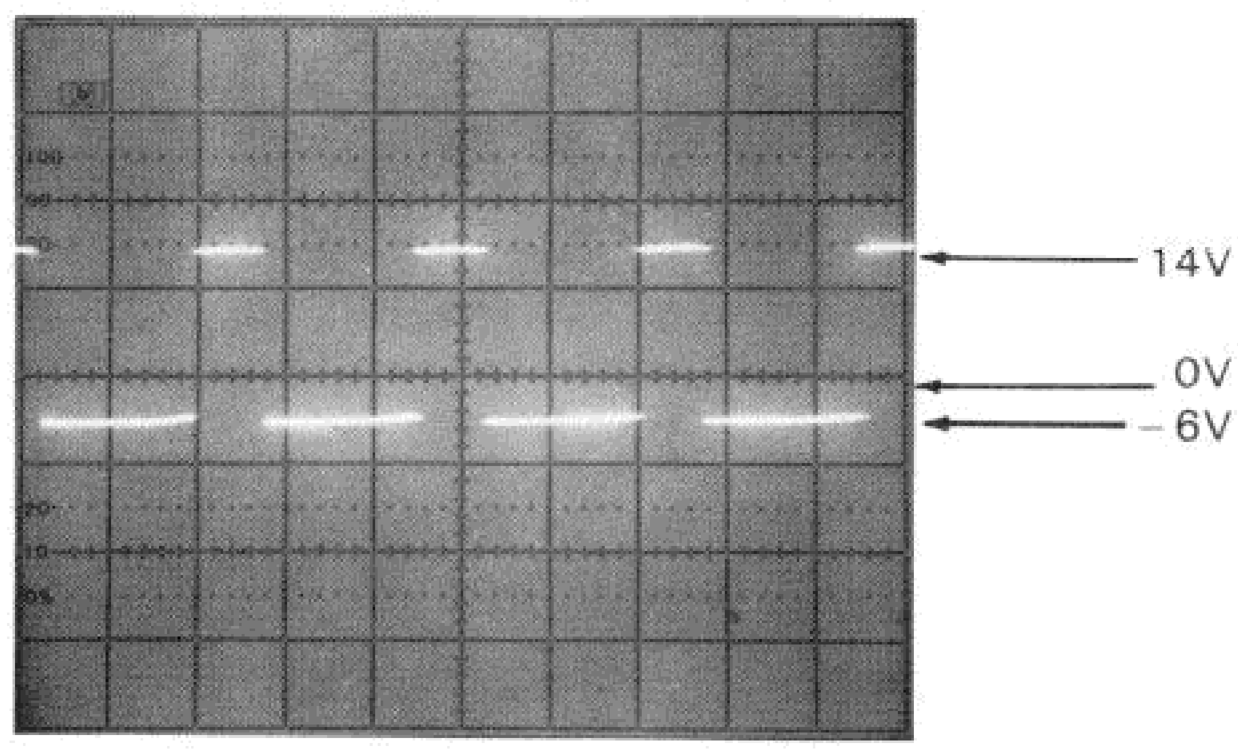



**Figure 1-8-F-1. CR712 Anode Waveform**

### 1-8-F-42. −15V Power Supply Troubleshooting

1-8-F-43. To troubleshoot the −15V supply, do the following:

a. Check TP −15V for a voltage of −15V (±.25V). If it is correct, the −15V supply is operating properly. If it is incorrect, proceed with step b.

b. Check TP VB for a voltage of 5.8V to 7.6V. If it is correct, proceed with step c. If TP VB is incorrect, the problem is most likely in the battery charger circuitry. Refer to paragraph 1-8-F-28 for troubleshooting.

c. Check TP +15V for a voltage of +15V (±.4V). If TP +15V is correct, proceed with step d. If the voltage is lower than 14.6V, the +15V supply is pulling down the −15V supply, in which case you should go to paragraph 1-8-F-37 for troubleshooting.

d. Lift one end of JM702 and then check TP −15V again. If it is still wrong, proceed with step e. If, however, TP −15V is now good, some device in the A/D section is drawing excessive current. To find out which device is defective, do the following:

1. Resolder JM702.

2. Refer to the power supply table on schematic 1 to identify the components that use the −15V supply. Then, using a high resolution voltmeter, probe the −15V power supply connections for the ICs that use this supply. The defective IC will have the largest voltage at its −15V power supply connection.

e. Resolder JM702.

f. Check regulating diode CR715, and capacitors C711 and C714. If these are OK, proceed with step g.

g. Using an oscilloscope set to a 20μs/div sweep time and a 10V/div vertical gain, check the collector of Q704 for the waveform shown in Figure 1-8-F-2. If it is incorrect, first check CR711. If CR711 is OK, check Q704 and Q705. If Q704 and Q705 are good, replace T701.

(20 μs/Div Sweep Time;
10V/Div Vertical Gain)

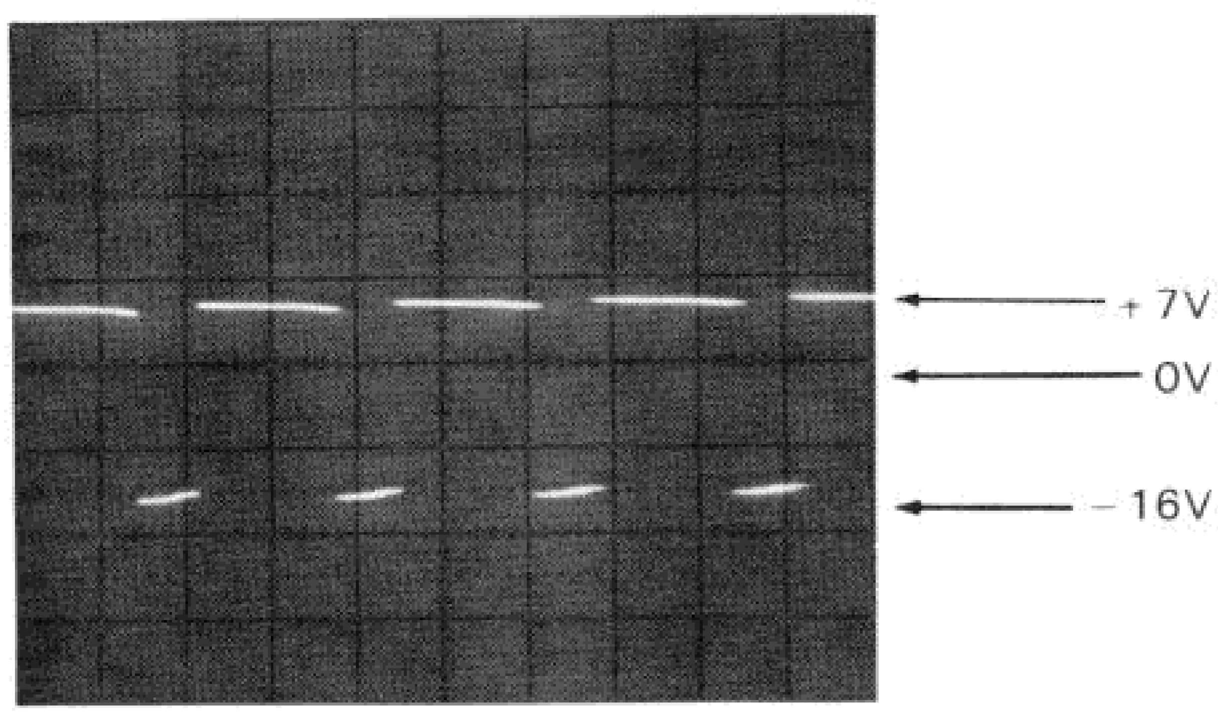



**Figure 1-8-F-2. Q704 Collector Waveform**

## 1-8-F-44. POWER UP/POWER DOWN CIRCUITRY TROUBLESHOOTING

1-8-F-45. Effectively, the HP 3421A has two power switches. The rear panel pushbutton (S700) removes all circuit power from the control logic and input circuitry. In addition, it removes power from most of the power supply circuitry. S700 serves as a master reset switch.

1-8-F-46. The front panel switch (S502) can be thought of as a power state "software" switch. When the front panel switch is pressed off (out), it grounds the interrupt line (LINT) of the U508 CPU thru CR584. This causes the CPU to access an interrupt service routine in ROMs U505 and U506, which in turn activates the Low Power Down (LPD) signal. LPD is inverted by U700B, which drives Q706 and resets relay K700. If for some reason the CPU does not send the LPD signal to U700B, relay K700 is then reset by Q708 and U701A. This happens when the LINT line goes low. It triggers one-shot multivibrator U701A, after a delay that is determined by R734 and C723, which in turn drives Q708 on. This causes relay K700 to reset. Since U701A is only used as a backup for the CPU, it is only effective if the CPU does not set the LPD line low. When K700 is reset, the VB path is opened. VB is required to develop +5V, +15V, and -15V.

**NOTE**

*On older HP 3421As (Serial Number 2338A03052 and below), only the CPU is able to set the LPD line low. Those instruments did not have the U701A and Q708 LPD backup circuitry.*

1-8-F-47. When the front panel switch is pressed on (in), the CPU interrupt line (LINT) is released. This allows the wakeup logic to generate the Low Power Up (LPU) signal. LPU triggers one-shot multivibrator U701B, which in turn drives Q707 causing the K700 relay to set. When K700 is set, the path for VB is restored.

1-8-F-48. Since K700 is a latching type relay, it remains in the state it is in, unless changed by activating its set or reset coil. That is, if the relay is set, the reset coil must be activated to place the relay in a reset state; if the relay is reset, the set coil must be activated to place the relay in a set state. To power down via the front panel switch, the CPU must access ROM to generate the LPD signal. To power up via the front panel switch, the wake up logic must generate the LPU signal. This means that power up/power down failures could be caused by the logic circuitry, or the circuitry that handles the LPU and LPD signals. Also, since the CPU will fail to run if its power supply drops below 4.7V, a power supply problem could cause a power up/power down failure.

1-8-F-49. In addition to that explained in the previous paragraph, the Low Low Battery (LLB) circuit can also affect power up and power down. This is explained in detail starting in paragraph 1-8-F-56. For now, however, understand that if a low battery voltage is detected during instrument operation, it causes the error indicator to turn on. The Model 3421A will then power down in about three minutes. However, if the HP 3421A is required to communicate on HP-IL or HP-IB, the three minutes will be extended. Both the error indicator and on indicator remain on after power down. If a low battery voltage is detected at power on, display segment 27 and the error indicator will turn on and remain on, followed by an instrument power down in about three seconds later.

**NOTE**

*On older HP 3421As (Serial Number 2338A03052 and below), the on and error indicators do not remain on when the instrument goes into the power down mode. For those instruments, the complete display goes blank.*

1-8-F-50. Another important thing to know about LPU and LPD is their respective states during power up, power down, and normal operation. Since LPD is used to power down the instrument, it should be high when the front panel switch is on. When the front panel switch is pressed off, LPD goes low. LPU, however, is used to trigger multivibrator U701, and is low when the front panel switch is on. Thus, when the front panel switch is pressed from off to on, LPU makes a transition from low-to-high and back low. It is the falling edge of LPU that triggers U701B.

1-8-F-51. Before troubleshooting a power up or power down failure, check TP +5V for +5V (±.25V). If TP +5V is incorrect, go to paragraph 1-8-F-35 for troubleshooting. Next, check signal Low Low Battery (LLB) at JM700 (JMLLB) for a TTL high (5V). If LLB is incorrect, go to paragraph 1-8-F-56 for troubleshooting. The troubleshooting procedures for the power up and power down failures are explained in the following paragraphs.

### 1-8-F-52. Power Up Failure Troubleshooting

1-8-F-53. This type of failure is when the instrument will not power up when the front panel switch is pressed on. Assuming you have checked the +5V power supply and LLB (see paragraph 1-8-F-51), do the following:

a. Use an oscilloscope and monitor TP LPU as the front panel switch (S502) is pressed on. If LPU does not go to 0V when S502 is pressed on, proceed with step b. If LPU goes to 0V, but the instrument still does not power up, do the following:

1. Press the front panel switch off.

2. Momentarily connect a jumper between pin 12 of K700 to ground. If the HP 3421A does not power up, K700 is defective. If it does, K700 is good. Using an oscilloscope set to a slow speed, monitor pin 10 of U701. The pin should make a transition from low-to-high and back to low, when the front panel switch is pressed. You may notice a switch bounce that causes U701 pin 10 to make the transition twice. This is normal. If the output is good, check for a defective Q707. If wrong, check for a defective U701.

b. First make sure that R731 is good. If R731 is good, there is a problem with either U531, U532, or S502. To isolate the problem, do the following:

1. Monitor U531 pin 8 with an oscilloscope and slowly press the front panel switch from off to on. When the front panel switch is off, U531 pin 8 should be low (0V). As the switch reaches midpoint, U531 pin 8 should go to VBATT. When the switch reaches its on position, U531 pin 8 should again go low (0V). If you do not see these transitions ocurring, first check R537. If R537 is OK, replace S502.

2. If U531 pin 8 checks good, trace the signal through U531C, U532B, U531D, and U531A. To do this, cycle the front panel switch from off to on as you check for transition at the output of each gate. Replace the IC containing the gate where transitions do not occur.

### 1-8-F-54. Power Down Failure Troubleshooting

1-8-F-55. This type of failure is when the instrument will not power down when the front panel switch is pressed off. Assuming you have checked the +5V supply, do the following:

a. Use an oscilloscope and monitor TP LPD as the front panel switch (S502) is pressed off. If LPD does not go to 0V when S502 is pressed off, proceed to step b. If LPD goes to 0V, but the instrument still does not power down, do the following:

1. Press the front panel switch on (in).

2. Set the oscilloscope to a slow sweep speed (i.e., .5s or slower), and then monitor U700 pin 1 as the front panel switch is pressed off again. You should see a fast pulse go low-to-high and then low again. If this does not occur, replace U700. If U700 pin 1 makes the transition, proceed with step 3.

3. Press the front panel switch on. Then monitor the collector of Q706 with an oscilloscope as the front panel switch is pressed off. The Q706 collector should make a transition from from the battery voltage to 0V and then back to the battery voltage. If this does not occur, either Q706 or Q708 is defective. Proceed with step 4. If it does occur and the HP 3421A still does not power down, first check CR705. If CR705 is good, replace K700.

4. With the HP 3421A turned on, check for a low level at the base of Q708. If the level is high, check for a defective U701A. If the level is low, lift the collector lead of Q708. Then turn the front panel switch off. If the power down operation is now good, replace Q708. If still inoperative, replace Q706.

b. Unsolder and lift one end of JM705.

c. Press the front panel power switch on. Now monitor U508 pin 27 as the front panel switch is pressed off, which should go low (0V). If U508 pin 27 is OK, proceed with step d. If U508 pin 27 does not make the high to low transition, do the following:

1. Make sure the front panel power switch is off and that U508 pin 6 (LINT) is approximately 0V. If it is not 0V, check for an open CR584 and switch S502. Replace if defective.

2. With the front panel switch on, use an oscilloscope to check the address lines (A0-A12) of ROM U506 to make sure they are all making transitions. If the address lines are OK, check the data bus lines (D0-D7) of ROM U506 to make sure they are all making transitions.

3. If any address line is stuck (high or low) it can be the fault of any component that connects to the address bus. If an address bit is stuck low, however, you can use a high resolution voltmeter and probe the stuck bit at the various devices. The defective device will have the largest voltage drop at the address pin sinking the current.

4. Like the address bits, a stuck data bit can be the fault of any component that connects to the data bus. If it is stuck low, you can use the high resolution voltmeter technique that was explained in step 3 to find the faulty component.

5. If both the address and data bus lines are OK, the CPU is probably defective. Refer to Service Group E for troubleshooting.

d. Replace U700 and resolder JM705.

### 1-8-F-56. LOW BATTERY CIRCUITRY TROUBLESHOOTING

1-8-F-57. This circuitry develops the Low Low Battery signal. LLB indicates that the main battery is low. If lLB is detected at power on, the display on indicator, display error indicator, and display segment 27 turn on, followed by an automatic instrument power down in about three seconds. If LLB is detected during operation, the display error indicator turns on followed by an instrument power down about three minutes later. However, if the HP 3421A is required to communicate on HP-IL or HP-IB, the three minutes will be extended. In both instances, the appropriate display indicators remain on after power down occurs.

**NOTE**

*On older HP 3421As (Serial Number 2338A03052 and below), the on and error indicators do not remain on when the instrument goes into the power down mode. For those instruments, the complete display goes blank.*

1-8-F-58. This circuitry can have three failures. One failure is when LLB is low all the time, even if the battery is not low. This failure will cause the instrument to power down about three seconds after power on, or, if the failure occurs during operation, a power down about three minutes after LLB is detected. The other failure is when LLB does not go low when the battery is low. This failure will result in the instrument not powering down if the battery voltage is low. This, ofcourse, could result in the battery becoming completely discharged if portable operation is continued. Another possible failure, which is not a part of LLB generation, is when the instrument does not respond to LLB (i.e., it does not power down when LLB is active). If this is ocurring, replace the U512 port expander.

1-8-F-59. The troubleshooting procedures for the two LLB failures are explained in the following paragraphs.

### 1-8-F-60. Instrument Powers Down After Turn On

1-8-F-61. This type of failure should cause the display error indicator and display segment 27 to turn on when the front panel switch is pressed on, followed by an automatic instrument power down about three seconds later. Before troubleshooting this failure, make sure TP VBATT is between 5.8V and 7.6V with the ac line cord unplugged. If VBATT is low, allow sufficient time for it to recharge before troubleshooting. Also, make sure that the ac line fuse and the battery fuse are good. If either fuse is blown, the battery will not charge when the instrument is plugged into the ac line. If VBATT and the fuses are OK, do the following:

a. Check the voltage at JM700. If it is 5V, but the instrument powers down when the front panel switch is pressed on, replace port expander U512. If JM700 is 0V, do the following:

1. Unsolder and lift one end of JM700.

2. Press the front panel switch on.

3. If the instrument still powers down when the front panel switch is pressed on, replace port expander U512. If the instrument no longer powers down when the front panel switch is pressed on, proceed with step 4.

4. Replace JM700.

5. Make sure the instrument is plugged into an ac outlet.

6. Check TP REF for 1.235V ($\pm$ 10mV). If it is incorrect, replace U703. If it is correct, check U700 pin 4 for 1.235V. If U700 pin 4 is correct, proceed with step 7. If U700 pin 4 is wrong, make sure R725 is good.

7. Press the front panel switch off and then monitor U700 pin 5 with a voltmeter as the switch is pressed on again. Before the instrument powers down, U700 pin 5 should go to about 1.5V. This voltage must be higher than the 1.235V reference. If U700 pin 5 is wrong, make sure R709, R710, and C702 are good. If they are OK, replace U700.

### 1-8-F-62. Instrument Does Not Power Down When Battery Is Low

1-8-F-63. The instrument is designed to power down if the main battery voltage is too low. The battery should be at 5.8V or above to use the instrument for portable operation. You should also note that a discharged battery (<5.8V and >1V) can take up to 16 hours to charge and a completely discharged battery (<1V) can take up to 48 hours to charge. Also, the battery may not be able to sustain repeated discharging to the point where it has little or no charge remaining. If the battery has been completely discharged four times or more, it is probably defective. To troubleshoot the circuitry, do the following:

a. Check TP VBATT for 5.8V to 7.6V. If the voltage falls within this range, you should not expect LLB to be active. If the battery voltage is low, proceed with step b.

b. Check U700 pin 2 for 0V. If it is correct, LLB is OK but the instrument is not responding properly. Replace port expander U512. If U700 pin 2 is not 0V, do the following:

1. Check TP REF for 1.235V (±10mV). If TP REF is incorrect, replace U703. If it is correct, proceed with step 2.

2. Check U700 pin 4 for 1.235V (±10mV). If this voltage is correct, proceed with step 3. If it is wrong, check resistor R725.

3. Check U700 pin 5 for a voltage that is less than TP REF (i.e., less than 1.235V). If U700 pin 5 is lower than TP REF but LLB is still high, replace U700. If U700 pin 5 is higher than TP REF (i.e., greater than 1.235V), check R709 and R710 to make sure they have not changed value.

### 1-8-F-64. POWER SUPPLY CURRENTS

1-8-F-65. As additional troubleshooting information, the typical power supply currents the instrument draws are listed in Table 1-8-F-2. Also listed is where the various currents can be checked. If any power supply current exceeds 10% of the typical value listed in the table, you should suspect that some device(s) that uses that supply is drawing too much current.

1-8-F-66. If some device draws excessive current, it can lower the voltage of the power supply that is providing power to the device. The actual voltage that will be read from the supply will depend upon how much excessive current is being drawn. You can locate the defective device by using a high resolution digital voltmeter to probe the power supply connections of all devices that use that supply. The defective device will have the largest voltage drop at its power supply connection(s). Normally, the difference in voltage that can be read between the devices that use the same supply is very small (usually a few mV), which is the reason a high resolution digital voltmeter is needed. This small voltage is developed by the current going through the trace to the device.

Table 1-8-F-2. Power Supply Currents

**NOTE**

*The currents listed in this table assume that no options are installed in the instrument.*

| Current | Typical Value | Check At |
|---|---|---|
| IBATT | 210 mA | Positive or negative lead of main battery with ac line cord unplugged. |
| I+5V | 125 mA | Cumulative current at JM102 and JM703. |
| I+15V | 10mA | JM701. |
| I-15V | 11 mA | JM702 |

# SERVICE GROUP G
# THEORY OF OPERATION

### Service Group G Contents



## 1-8-G-1. INTRODUCTION

1-8-G-2. This service group contains a basic and detailed description of the HP 3421A circuitry. The basic description explains the purpose of various operating blocks shown in Figure 1-8-G-1. The detailed description explains the circuitry within each operating block.

## 1-8-G-3. BASIC BLOCK DIAGRAM DESCRIPTION

1-8-G-4. Refer to Figure 1-8-G-1 for the following discussion.

1-8-G-5. The HP 3421A circuitry can be separated into three major categories: measurement, control circuitry, and power supply. The measurement circuitry consists of the input circuitry, A/D converter, ohms current source, and ac to dc converter. The control circuitry is used to set up the measurement circuitry for a particular function and range, calculate readings, send and receive remote information, and control the front panel display (for channel numbers). The power supply provides the various operating voltages for the instrument.

1-8-G-6. The following paragraphs explain a typical measurement sequence, and the power supply wake up logic.

**a. Set-up.** Since the HP 3421A does not have any front panel range or function keys, a controller is needed to send this type of information over HP-IL (or HP-IB if the HP 3421A is so equipped). Upon receiving the information, the HP 3421A CPU sets up the measurement circuitry as required. The CPU also sends information to the display to show the selected channel.

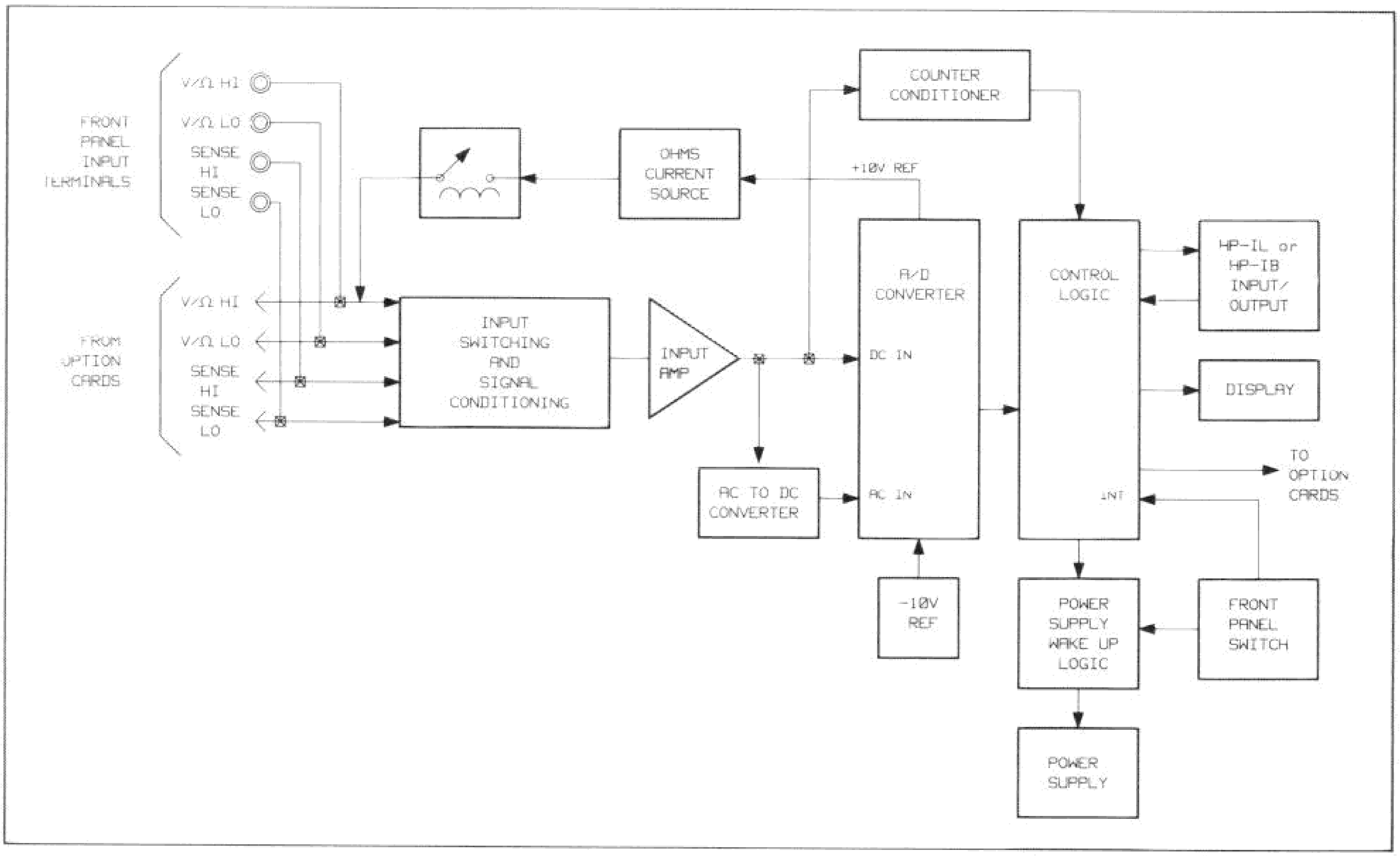



**Figure 1-8-G-1. HP 3421A Basic Block Diagram**

**b. DC Volt Function.** The following occurs if the dc volt function is selected.

1. The CPU closes the input relay associated with the range selected. The input circuitry gain will depend upon the input path selected.

2. The input voltage is either amplified or attenuated to anywhere between −10V to +10V, depending upon the amplitude and polarity of the input. This voltage is then applied to the A/D converter.

3. The A/D converter changes the voltage to a digital representation and then sends it to the CPU.

4. The CPU takes the digital data and calculates the correct reading. The reading is calculated by using zero measurement (see step e) and calibration constants stored in the calibration RAM.

5. The reading is stored and then sent over HP-IL (or HP-IB) when directed by the system controller. If, however, the controller directs another reading to be taken before the previous reading is sent, the previous reading will be lost because the HP 3421A buffer only has single reading storage capability.

**c. Ohms Function.** When the controller selects the ohms function, the HP 3421A ohms current source supplies a dc current through an unknown resistance. This produces a voltage drop which is applied to the input terminals. A dc voltage measurement is then made which the CPU uses to calculate the ohms measurement. This calculation is done using the zero measurement (see step e) and the calibration constants stored in the calibration RAM.

**d. AC Volts Function.** When the controller selects the ac volt function, the input is routed through the ac to dc converter. The converter changes the average value of the input ac voltage to an equivalent dc voltage. This dc voltage is applied to the A/D converter. The A/D converter changes the voltage to a digital representation and sends it to the CPU. The CPU calculates the correct reading using the zero measurement and calibration constants.

**e. Autozero Function.** When the controller selects the autozero function, an offset measurement is made before an input measurement is taken. This offset measurement is known as the zero measurement, and is stored in the calibration RAM to be used as a zero calibration constant. This constant is subtracted from dc volts, ac volts and ohms readings that follow.

**f. Power Supply Wake Up Logic and Front Panel Switch.** The HP 3421A mainframe and the relay multiplexer option use latching type relays. Unless provisions were made to open this type of relay when a power down occurs, it would remain closed. This circuitry ensures that whenever the front panel switch button is pressed off, all analog input relays, and the mainframe relay that provides power to the instrument, will be opened before circuit power is removed. If the HP 3421A happens to be in a loop power down and the switch is pressed off, it will cause the power supply to return power long enough for the CPU to open all channels before circuit power is removed. This is explained in detail starting with paragraph 1-8-G-87.

## 1-8-G-7. DETAILED THEORY OF OPERATION

### 1-8-G-8. Introduction

1-8-G-9. The remainder of this service group contains the detailed theory of operation. It may be helpful to refer to the detailed block diagram and schematics in Service Group H for the remaining explanations. The circuitry is explained as follows:

a. Input Circuitry - paragraph 1-8-G-10.
b. Ohms Current Source - paragraph 1-8-G-17.
c. AC to DC Converter - paragraph 1-8-G-25.
d. A/D Converter - paragraph 1-8-G-29.
e. Control Logic Circuitry - paragraph 1-8-G-72.
f. HP-IL Operation - paragraph 1-8-G-95.
g. Rear Panel Switch - paragraph 1-8-G-97.
h. Power Supply - paragraph 1-8-G-99.

### 1-8-G-10. Input Circuitry

**1-8-G-11. General.** The purpose of the input circuitry is to condition the ac or dc input signals for the A/D converter. Both ac and dc input signals use the same input circuitry, except that ac signals are routed through the ac to dc converter before being input to the A/D converter. The input circuitry consists of several different stages and is explained as follows:

a. Overvoltage Protection - paragraph 1-8-G-12.
b. Input Switching - paragraph 1-8-G-13.
c. Autozero - paragraph 1-8-G-14.
d. Precharge Stage - paragraph 1-8-G-15.
e. Input Amplifier - paragraph 1-8-G-16.

**1-8-G-12. Overvoltage Protection.** There are two parts to this circuitry: high voltage protection, and low voltage protection. These are explained in the following paragraphs.

*a. High Voltage Protection.* This circuit consists of a 630V voltage surge protector (E101), two 51kΩ resistors (R108, R109), and a .01 μF capacitor (C104). The circuitry is connected between the Ω/V HI and Ω/V LO input terminals. E101 will conduct if the peak level of an input signal reaches 630V (±20%). When E101 conducts, a path is provided to ground. R108 and R109 provide current limiting when E101 conducts continuously. C104 provides a temporary low impedance path for voltage transients, thereby protecting R108 and R109.

*b. Low Voltage Protection.* This circuit consists of diodes within U102 that are connected between +3.5V and −3.5V on all input lines. A diode will conduct if the node where the diodes are connected exceeds either a +4.2V or −4.2V, thereby clamping the node to ±4.2V. The difference between the input voltage and the node voltage where the diodes are connected is dropped across series resistors on the input line. Figure 1-8-G-2A shows a schematic representation of the low voltage protection circuit.

**1-8-G-13. Input Switching.** The input switching circuitry consists of relays and MOSFET switches. The FET switches are located in U102. The purpose of this switching circuitry is to provide different paths to the input amplifier, with each path having different levels of attenuation. This circuitry also configures the input amplifier for a zero measurement (see autozero function, paragraph 1-8-G-14). The following explanations are for the various input paths. For these explanations, refer to Figure 1-8-G-2 and/or the schematics in Service Group H.

*a. Low Voltage Range Input Path (Figure 1-8-G-2B).* This path consists of K101, R103, R104, and S1 (S1 is in U102). This path is used on the .3Vdc and 3Vdc ranges, and all ohms ranges to connect the Ω/V HI terminal to the input amplifier. The Ω/V LO terminal is referenced to ground.

*b. High Voltage Range Input Path (Figure 1-8-G-2C).* This path consists of K103, S2 (S2 is in U102), and 9.9MΩ and 100kΩ resistors (also in U102). This path attenuates the input signal by a factor of approximately 100 and then routes the attenuated signal to the input amplifier. This path is used on the 30Vdc and 300Vdc ranges, and on both ac ranges.

*c. Ohms High Sense Path (Figure 1-8-G-2D).* This path consists of R105, R106, S3, S4, and S5 (S3, S4 and S5 are in U102). This path connects the ΩHI Sense Terminal to the input amplifier for 4-wire ohms measurements. Switch S5 is open for the 4-wire ohms function, and closed for all other functions. When S5 is closed, any voltage that might appear at the junction of S3 and S4 is shunted to ground.

*d. Ohms Low Sense Path (Figure 1-8-G-2E).* This path consists of R101, R102, S6, and S7. Its purpose is to connect the ΩLO Sense terminal to ground when the 4-wire ohms function is selected. For the 2-wire ohms function, the low ohms lead is the Ω/V LO terminal which is connected directly to ground.

**1-8-G-14. Autozero.** The autozero function is used to measure the offset voltage of the input amplifier and substract it from the input measurement. When autozero is enabled, an offset measurement is taken between each input measurement. The offset measurement is called "measure zero" and is done in two different ways, depending upon the selected function. These are as follows:

*a. Autozero (DC Volts, and 2-wire Ohms).* In these modes, the offset measurement (measure zero) is made with switch MC (measure customer) open, and switches MZ (measure zero) and S8 closed, as shown in Figure 1-8-G-2F. With switches MZ and S8 closed, the input of the input amplifier is connected to ground through a 102kΩ resistor. After the offset measurement is made, switches MZ and S8 are opened and switch MC closed so the input measurement can be made. Switches MC, MZ, and S8 are in U102.

*b. Autozero (4-wire Ohms).* In this mode, the offset measurement is made with switches MC and S8 open and switches MZ and S6 closed. The input amplifier is connected to ground through an externally connected lead to the Ω/V LO Terminal as shown in Figure 1-8-G-2G. This configuration is different than the 2-wire ohms in that the input amplifier is connected to ground through an external connection. After the offset measurement is made, switch MC is closed and switches MZ and S6 are opened.

*c. Autozero (AC Volts).* In this mode, the input circuitry is set up for ac volts. The A/D converter then takes a reading on its ground and the input signal. These readings are then subtracted to null out offset errors in the A/D converter.

**1-8-G-15. Precharge Stage (Figure 1-8-G-2H).** A small stray capacitance exists within U102 between the line going to the positive input of the input amplifier (U101) and ground. During a zero measurement, there will be no voltage across this capacitance. However, when an input measurement is made, this capacitance will start charging. This charging action could temporarily load down the input voltage, resulting in an incorrect reading. To prevent this, the input to the input amplifier is "precharged" to the input voltage before the input measurement is made. This is done by the precharge amplifier and switch PRE (both in U102). The circuit operation is as follows:

a. After the zero measurement is made, switch PRE closes while switch MC is still open.

b. The input voltage is routed to the precharge amplifier via the appropriate input path.

c. The precharge amplifier is a non-inverting X1 amplifier. Thus, the output of the precharge amplifier is the same as its input, and is routed to the input amplifier through switch PRE. This precharges the stray capacitance to the input voltage.

d. Switch PRE then opens and switch MC closes for an input measurement to be made.

e. For the next measurement, a zero measurement is made (in autozero mode) and the cycle repeats.

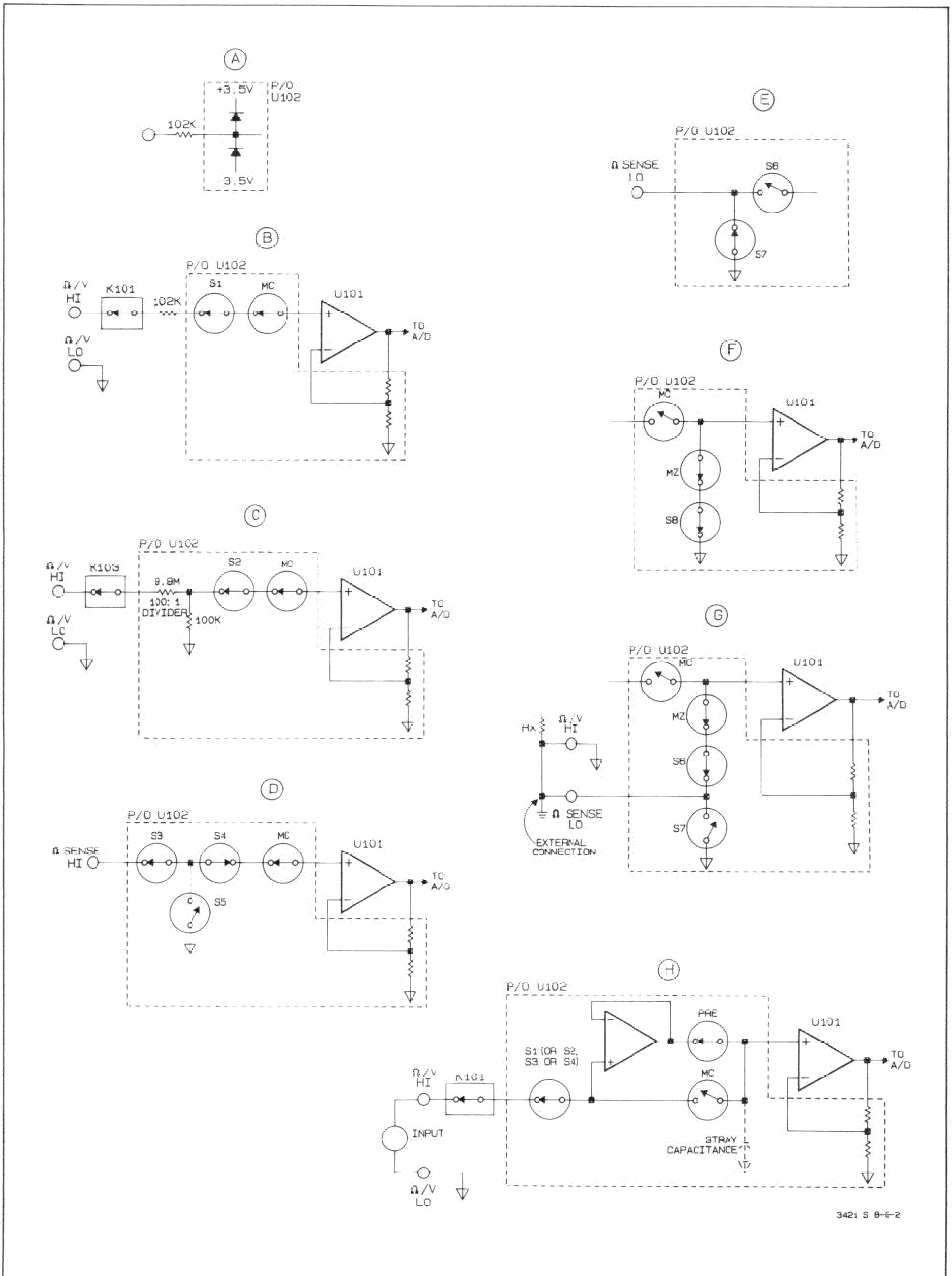



**Figure 1-8-G-2. Simplified Schematic of the Input Switching Circuitry**

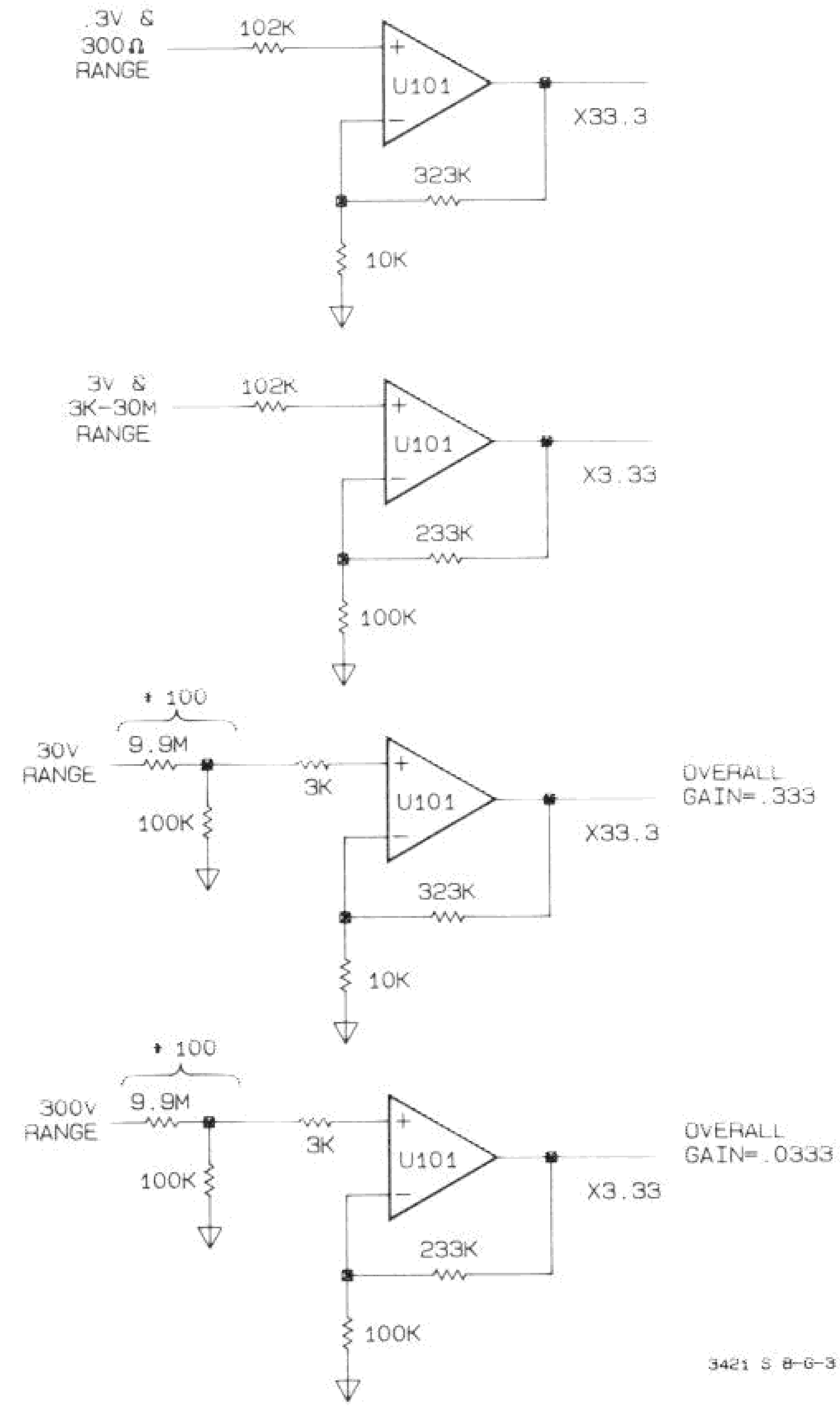



**Figure 1-8-G-3. Simplified Schematics Of The Input Amplifier Gain**

**1-8-G-16. Input Amplifier.** The purpose of the input amplifier, in conjunction with the input switching circuitry, is to condition the input signals. For full scale inputs, the output of the amplifier will be 10Vdc for dc and ohms measurements and 10Vac (RMS) for ac measurements. The amplifier gain is either X3.33 or X33.3, depending upon the range selected, as shown in Figure 1-8-G-3. Note, however, that the overall circuit gain for two of the amplifier configurations is X.333 and X.0333. This is because of the input resistors which attenuate the signal by 100. For these two circuits, an amplifier gain of X33.3 is reduced to an overall circuit gain of X.333 (33.3/100); an amplifier gain of X3.33 is reduced to an overall circuit gain of X.0333 (3.33/100).

### 1-8-G-17. Ohms Current Source

1-8-G-18. The purpose of the ohms current source is to provide a stable current for resistance measurements. The current is applied to the unknown resistance and the resultant voltage drop is measured. From this voltage measurement, the HP 3421A calculates the resistance value.

1-8-G-19. The ohms current source consists of the following circuitry: voltage reference, buffer, range resistors, output FET, gate bias amplifier, overvoltage protection, and ohms switching relay. In addition, several FET switches (inside U102) are used to select the required gain characteristic by switching various resistors (also in U102) in or out of the circuit. The following paragraphs explain how the ohms circuitry operates. Refer to Schematic 1 and Figure 1-8-G-4 for the explanations.

**1-8-G-20. Ohms Current Generation.** The explanation of ohms current generation is as follows:

a. The voltage reference (U201) output is +12V for all ranges, except the 30MΩ range where it is +8.4V. The U201 output is applied to the positive terminal of buffer U202. The output of U201 is also divided down to +8V, irrespective of range, by resistor R201 and feedback resistors RR3 and RR4. This +8V is applied to the positive input of U203.

b. The output of buffer U202 is +12V (or +8.4V for the 30MΩ range). This +12V is routed through one of the range resistors (RR5, RR6, RR7, or RR8, depending upon the range) to the negative input of the gate bias amplifier (U203).

c. U203 is a high gain operational amplifier with both its inverting and non-inverting inputs at +8V. The inverting input, therefore, draws little or no current. This results in a 4V drop across the selected range resistor (or .4V for the 30MΩ range).

d. A current is then generated that is proportional to the value of the range resistor and the voltage drop across the range resistor. For example, refer to the first circuit shown in Figure 1-8-G-4. Notice that the negative input to U202 is +12V. Also notice that the negative input to U203 is +8V because it follows the positive input. This leaves 4V to be dropped across the range resistor. In this example, therefore, the ohms current is 1mA (4V/4kΩ). In the second circuit, the ohms current is .1mA (4V/40kΩ).

e. The ohms current is applied to the unknown resistance through the output PMOS FET (in U102) and high voltage protection circuitry, to the Ω/V HI input terminal. The various ohms ranges, currents, ranges resistors, and closed FET switches are listed in Table 1-8-G-1.

**Table 1-8-G-1. Ohms Current and Ranges**

| Ohms Range | Ohms Current | Range Resistor | Resistor Voltage | FET Switches Enabled |
|---|---|---|---|---|
| 300-3k | 1mA | 4k (RR5) | 4V | S0R, S2R, S3R, S6R, S7R, S14R |
| 30k | .1mA | 40k (RR6) | 4V | S0R, S2R, S3R, S8R, S9R, S14R |
| 300k | .01mA | 400k (RR7) | 4V | S0R, S2R, S4R, S10R, S11R |
| 3M | 1μA | 4M (RR8) | 4V | S0R, S2R, S12R, S13R |
| 30M | .1μA | 4M (RR8) | .4V | S1R, S5R, S12R, S13R |

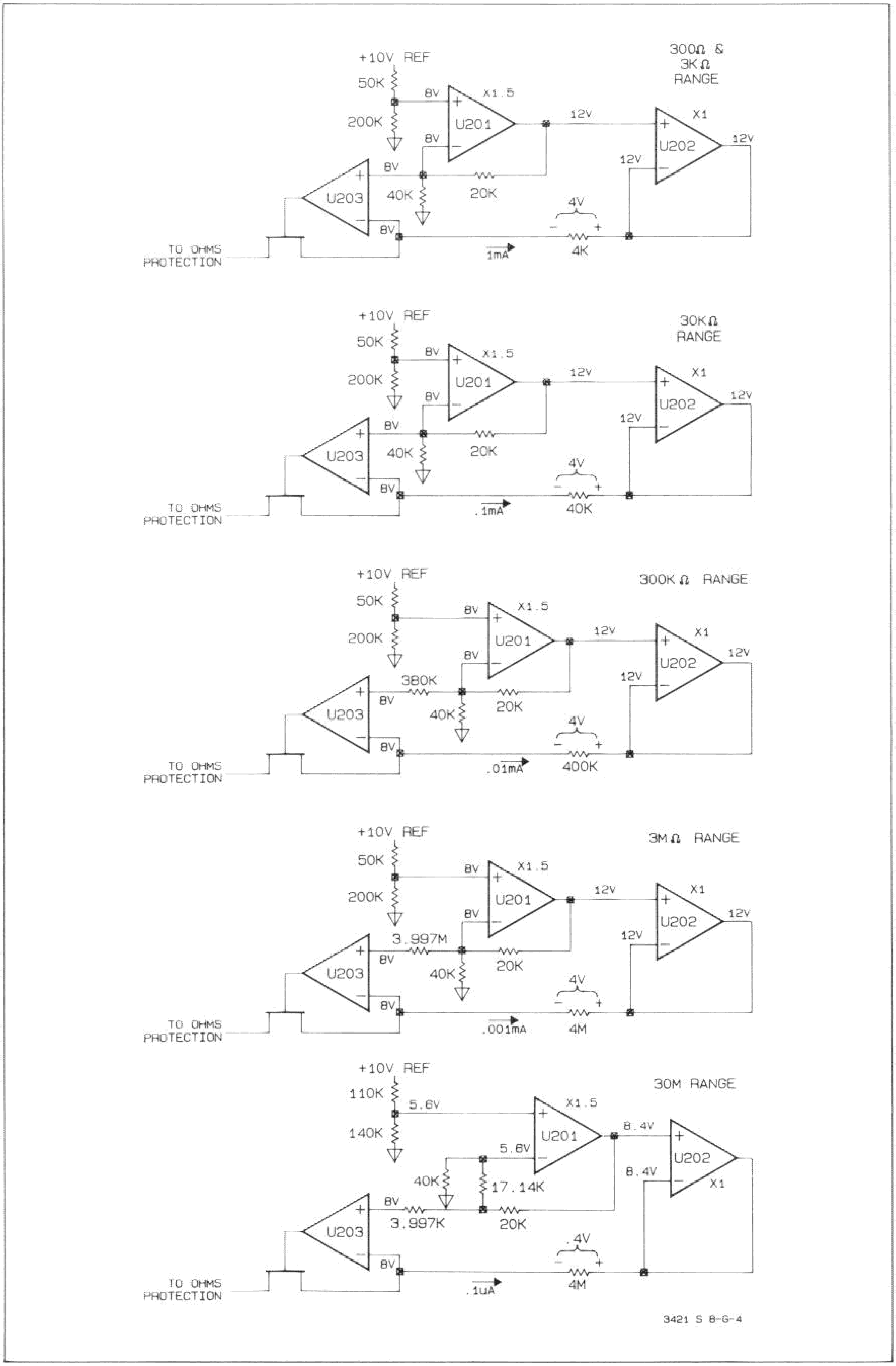



Figure 1-8-G-4. Ohms Circuitry Configuration

**1-8-G-21. Voltage Reference (U201).** The following explanation is for the voltage reference circuitry.

a. The voltage reference (U201) is a non-inverting amplifier with a X1.5 gain. The output of U201 is +12V for the 300Ω to 3MΩ ranges, and +8.4V for the 30MΩ range. The 1.5 gain factor is determined by R201 and feedback resistors RR3 and RR4. Since the combined series resistance of RR3 and RR4 is approximately 20kΩ and R201 is 40kΩ, the 1.5 gain is calculated as follows: 20k/40k + 1.

b. The +12V output is generated by applying +8V to the amplifier input. The +8V input is derived from the +10V reference and the voltage divider action of RR0, RR1, and RR2. The +8V appears at the junction of RR0 and RR1 and is input to U201 by closing switch S0R.

c. The +8.4V output for the 30MΩ range is generated by applying +5.6V to the input of U201 (5.6 x 1.5V = 12V). Like the +8V input used for the other ranges, the +5.6V is generated by the +10V reference and the voltage divider of RR0, RR1, and RR2. The +5.6V appears at the junction of RR1 and RR2 and is input to U201 by closing switch S1R.

**1-8-G-22. Buffer (U202) and Range Resistors (RR5-RR8).** The U202 buffer is a non-inverting, X1 gain amplifier whose output is either +12V or +8.4V (+8.4V is for the 30MΩ range only). The gain is selected by FET switch pairs S6R/S7R, S8R/S9R, S10R/S11R, or S12R/S13R. The range resistor selected determines the ohms current value as noted in Table 1-8-G-1.

1-8-G-23. The gate bias amplifier (U203) and output PMOS FET (in U102) provide a high output impedance for the ohms current source. A high output impedance is necessary to prevent measurement nonlinearity.

**1-8-G-24. Overvoltage Protection Circuitry.** This circuitry protects the ohms current source from high voltages inadvertently input to the HP 3421A while it is in the ohms function. The circuit operation is as follows:

a. If a large positive voltage is applied to the Ω/V HI Terminal, it will reverse bias CR201 and thereby prevent damage to the current source.

b. If a large negative voltage is applied to the Ω/V HI Terminal, it is dropped across R204, L201, CR201, R203, and R202 to FET Q205 (which acts like a diode). This causes Q205 to conduct which clamps the base of Q202 to −.7V. This turns on Q201, Q202, Q203 and Q204. Since the circuit that generates the ohms current cannot tell the difference between a valid unknown resistance and a large negative input voltage, Q201 and Q203 never conduct more current than is generated by the ohms current source. Additionally, most of the large negative input voltage is dropped across R202 and R203.

c. R204 and L201 limit initial current pulses that could exists under static discharge conditions.

**1-8-G-25. AC to DC Converter**

1-8-G-26. This circuit converts input ac voltages to dc voltages. See Figure 1-8-G-5. Input signals are capacitive coupled through C304 and C305. Zener diodes CR302 and CR303 protect the coupling capacitors from input voltages greater than 12 volts. U301A and U301b and associated components form a full wave rectifier. The ac input is applied to the inverting input of U301A through R302. During the positive going portion of the input signal, the output of U301B (VR) is a negative going signal which is equal in amplititude but 180 degrees out of phase with the input signal (VIN). At this time VO goes positive with an amplitude equal to the summation of the currents produced by VIN/25.2k and – VR/12.6k times the feedback resistance of U301A (– 8.4k). During the negative going portion of the input signal, CR301 is reverse biased and VR is 0. CR300 provides feedback to prevent U301B from going into saturation. VO again goes positive to an amplitude equal to ⅓ VIN (VIN/25.2k times the 8.4k feedback resistance). This results in a full wave rectified composite output of the summing amplifier.

1-8-G-27. After the ac to dc conversion, the rectified dc voltage is amplified by U301A and then filtered by R305, R306, R307, C301, C302, and C303. The filtered dc voltage is buffered by U301D and then routed to the ACINS input of the A/D converter.

1-8-G-28. The input circuitry used for the ac volt function (i.e., the circuitry before the ac to dc converter) is the same circuitry that is used for the dc volts function. Although the input circuitry is the same for the ac and dc volt functions, ac volts has only two ranges, 3V and 30V. The input circuitry operation, however, is essentially the same for both functions. The only difference is that in the ac function, ac signals are input; in the dc function, dc signals are input. The circuit operation for the input circuitry has already been explained.

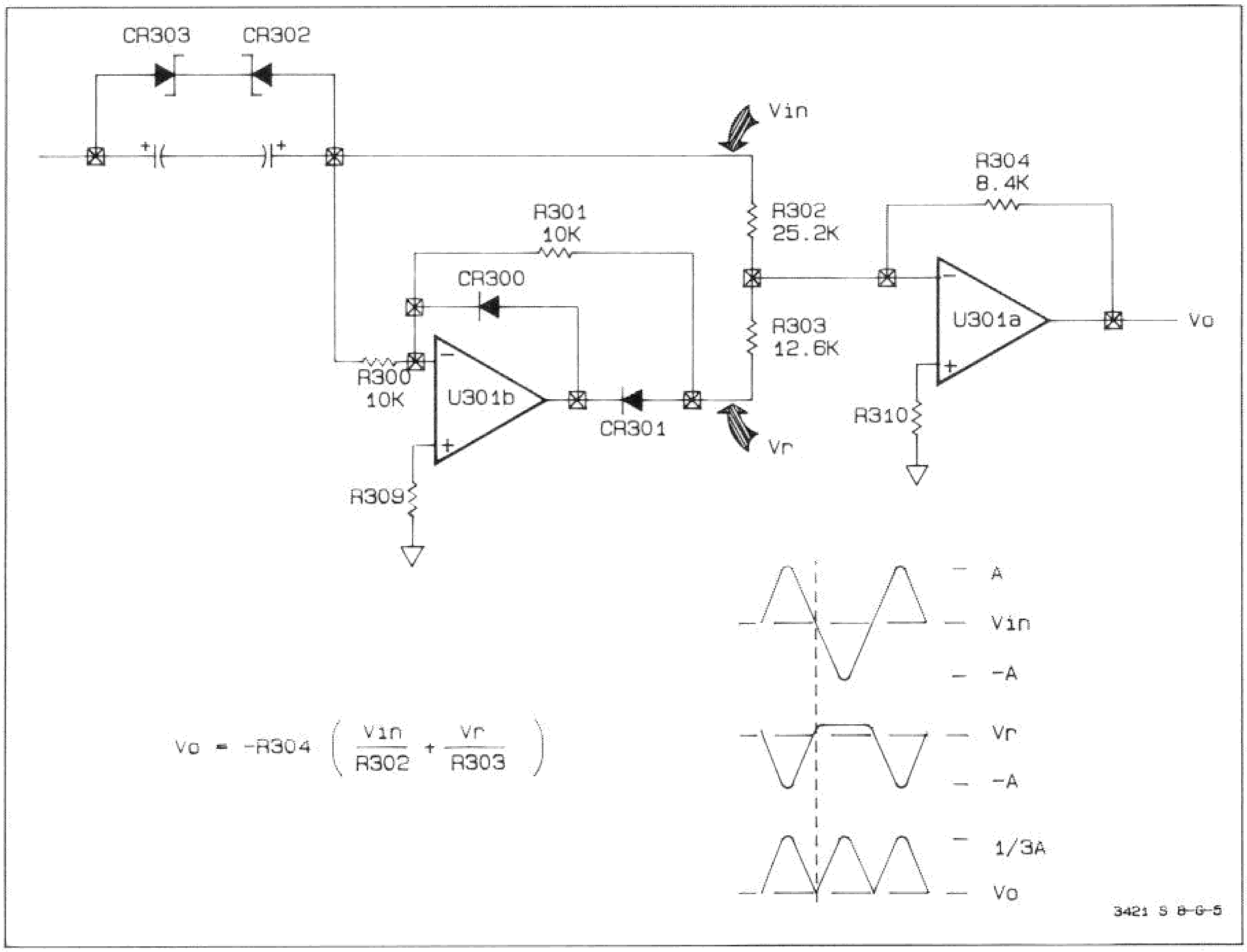



Figure 1-8-G-5. AC to DC Converter

## 1-8-G-29. A/D Converter

1-8-G-30. The A/D converter generates a digital representation of dc voltages applied to its input (input ac voltages have been rectified to dc voltages before they reach this stage). This circuitry consists of an integrator (U401 and associated circuitry), – VREF (CR401 and associated circuitry), and the A/D Hybrid (U403). The circuit operation is controlled by the CPU (U508).

1-8-G-31. The A/D conversion method used by the HP 3421A is called multi-slope II. This method has two states: runup and rundown. The most significant digits of the reading are determined during runup, and the least significant digits are determined during rundown. The combined time for runup and rundown (integration time) depends on the number of digits selected (3 1/2, 4 1/2, or 5 1/2). Multi-slope II is explained in the following paragraphs.

**1-8-G-32. Multi-Slope II Conversion.** In this process an integrator capacitor is charged and discharged by an unknown input voltage and known reference. The following explanations are for both the runup and rundown states in a 4½ digit configuration.

**1-8-G-33. Runup.** The runup state for the 4½ digit mode is illustrated in Figure 1-8-G-6. The solid line represents a hypothetical input value; the dashed line represents a larger hypothetical input value. Figure 1-8-G-7 shows a simplified schematic of the A/D converter, which should be helpful in understanding the circuit operation.

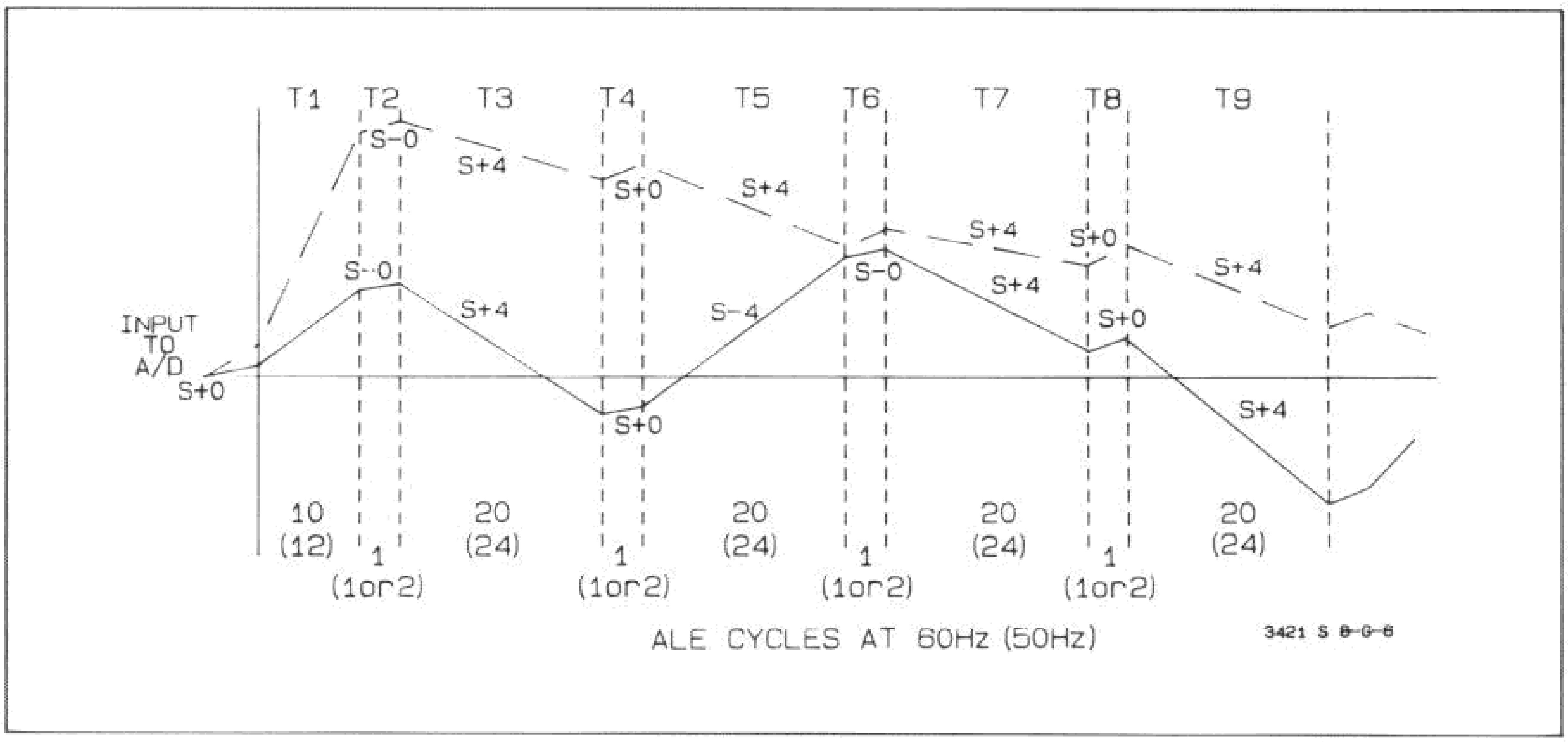



**Figure 1-8-G-6. Runup Slopes (4 ½ Digit Mode)**

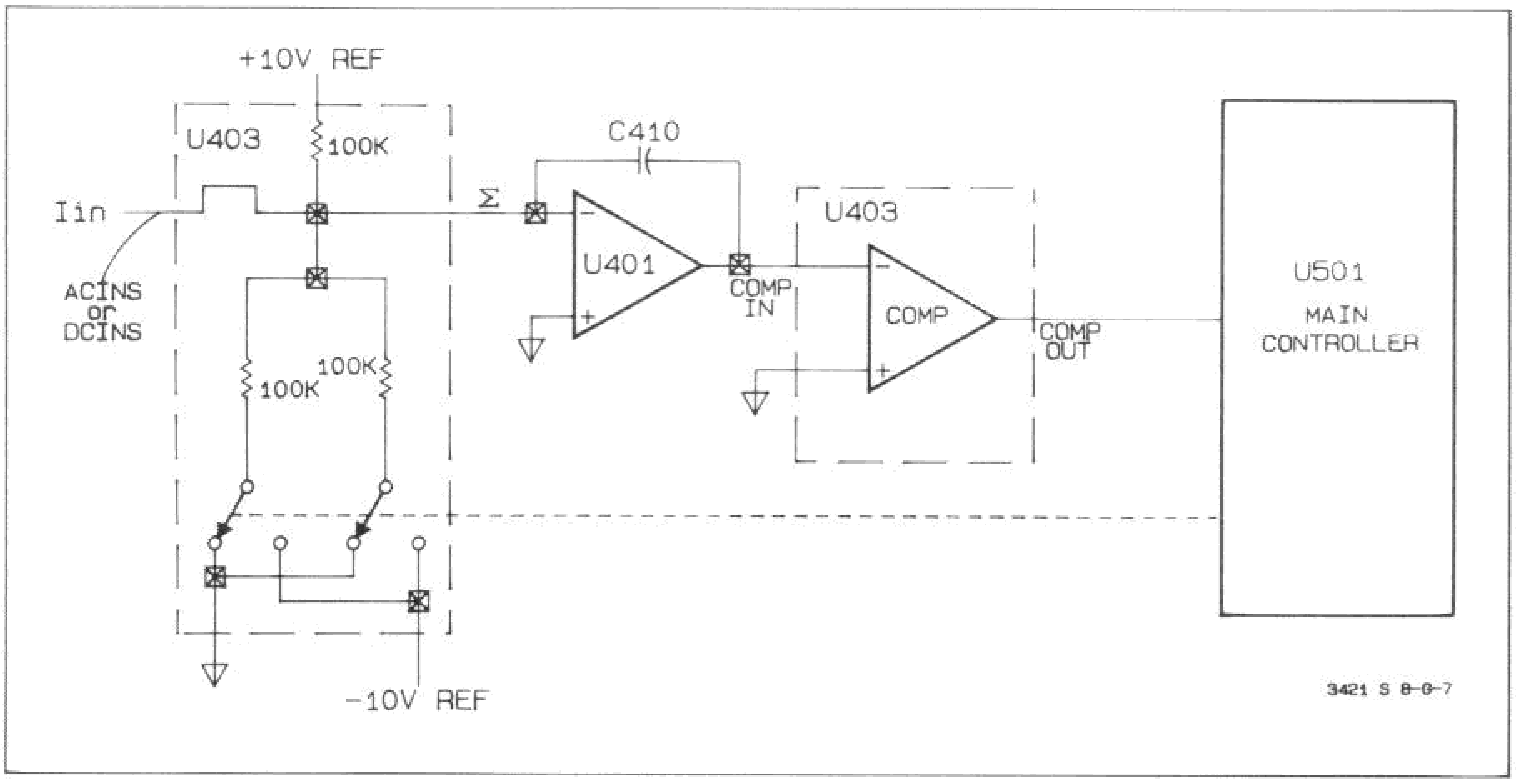



**Figure 1-8-G-7. Simplified A/D Converter**

1-8-G-34. When runup starts, the integrator capacitor (C410) is charged by the input current develped as a result of the input voltage. The input current is applied to the negative terminal of integrator U401. The output of U401 is negative for positive input currents, and positive for negative input currents.

1-8-G-35. The period of time when C410 is being charged only by the input current is called a "no current" condition due to the fact that no current, other than the input current, charges C410. The resultant slope is called S+0 or S−0. These will be explained later. The first slope that results from the input current is S+0 and occurs just prior to time T1.

1-8-G-36. When time period T1 starts, the S−4 negative current is applied along with the input current. The S−4 current is generated within the instrument. Since the input current and S−4 have the same polarity, both charge C410 for 10 ALE cycles (or 12 ALE cycles for 50 Hz operation). If the input current had the opposite polarity, C410 would still charge but the output slope would not be as steep. The reason for this is that the S−4 current is usually larger than the input current.

1-8-G-37. In the previous two paragraphs, the polarity of the S+0 and S−4 currents and where they are generated was explained. This is an important consideration in understanding multi-slope II conversion. The S+0 current, which was applied first, resulted from the input measurement. The polarity of S+0, therefore, depends upon the polarity of the input. If there is no input current, then S+0 is zero and the resultant S+0 slope will be flat (see Figure 1-8-G-8). The S−4 current was generated within the instrument and its polarity is always fixed (negative). Later, the S−0 and S+4 currents are explained. These currents can be considered counterparts of the S+0 and S−4 currents. As we will see, the S−0 current has the same polarity as S+0, but S+4 has the opposite polarity of S−4. This concept should become clear in the following explanations.

1-8-G-38. At the end of time period T1, the S – 4 current is removed. A "no current" condition (slope S – 0) will then exist for one 1 ALE cycle (or 2 ALE cycles for 50 Hz operation). This corresponds to time period T2. During T2, the charge rate of C410 is determined by the input current only, and therefore the slope is not as steep as when both currents were applied during time period T1. Notice that the S – 0 slope has the same charge rate as the S + 0 slope. This is because S + 0 and S – 0 are both a result of the input measurement. The major difference between the two is how they are generated (see paragraph 1-8-G-50). The two slopes are selected alternately (S + 0, S – 1, S + 0, etc.) for the "no current" conditions.

1-8-G-39. When time T3 starts, the S + 4 current is applied for 20 ALE cycles (or 24 ALE cycles for 50 Hz operation). The S + 4 current is generated within the instrument, as was the S – 4 current. S + 4 has the same value as S – 4, but it has the opposite polarity. Notice in Figure 1-8-G-6 that we have two conditions. The charge across C410 that resulted through time T2 is much less for the smaller input (solid line) as it is for the larger input (dashed line). For the smaller input, C410 discharges through zero and charges in the opposite direction during the T3 time period. For the larger input, C410 will discharge but it will not discharge through zero during T3.

1-8-G-40. At the end of time T3, the CPU checks to see if C410 has discharged through zero. If a zero crossing has occured, the U403 comparator output (pin 11) will have changed states. In the examples shown in Figure 1-8-G-6, a zero crossing occurred for the smaller input (solid line), but did not occur for the larger input (dashed line). For the moment, disregard time T4 and consider T5. Notice that if a zero crossing did occur, the S – 4 current is applied during T5; if it did not occur the S + 4 current is applied during T5. When a zero crossing occurs, the S – 4 current applied during T5 causes C410 to discharge, cross zero again, and charge back to the polarity it had during T1. However, this time the charge across C410 is greater because S – 4 is applied longer.

1-8-G-41. In the previous paragraph it was noted that the CPU checked for a zero crossing at the end of T3. If it occurred, the S – 4 current was applied in the next 20 (or 24) ALE time period (T5). If it did not occur, S + 4 was applied in that time period. The CPU also checks for a zero crossing at the end of T5, T7, and T9. The CPU uses the shorter time periods (T4, T6 and T8) to log whether or not the zero crossing occurred and to set up which current will be applied next (S – 4 or S + 4).

1-8-G-42. During T4, the S + 4 current is removed and a "no current" condition exists (slope S + 0) for 1 ALE cycle (or 2 ALE cycles for 50 Hz operation). T4 has the same period as T2. The remaining S – 0 and S + 0 slopes that follow are also 1 or 2 ALE cycles.

1-8-G-43. Again, refer to Figure 1-8-G-6 and consider the smaller of the two inputs (solid line). As previously explained, the CPU checks for a zero crossing at the end of T3, T5, T7 and T9. Let's examine this more closely. At time T5, the S – 4 current is applied as a result of the zero crossing that occurred during T3. Notice the direction of the zero crossing in T3. Also notice that there is a zero crossing during T5, but it is opposite to the T3 crossing. The zero crossing during T5 results in the S + 4 current being applied during T7. Thus, if there is a zero crossing, its direction will determine whether the S – 4 or S + 4 current is applied in the next 20 (or 24) ALE time period.

1-8-G-44. This charging and discharging action continues until the runup operation is completed. The CPU then uses the number of zero crossings and when they occurred to calculate the two most significant digits of the reading.

**1-8-G-45. Zero Inputs.** Figure 1-8-G-8 illustrates the runup slopes that occur for a zero input in the 4½ digit mode. Notice that the S+0 and S−0 slopes are flat. The reason is that they are a result of the input measurement. And, since the input is zero, there is no current during S+0 or S−0.

1-8-G-46. The S−4 and S+4 slopes are fixed and generated within the instrument. For a perfect zero reading the number of S−4 and S+4 slopes will be identical.

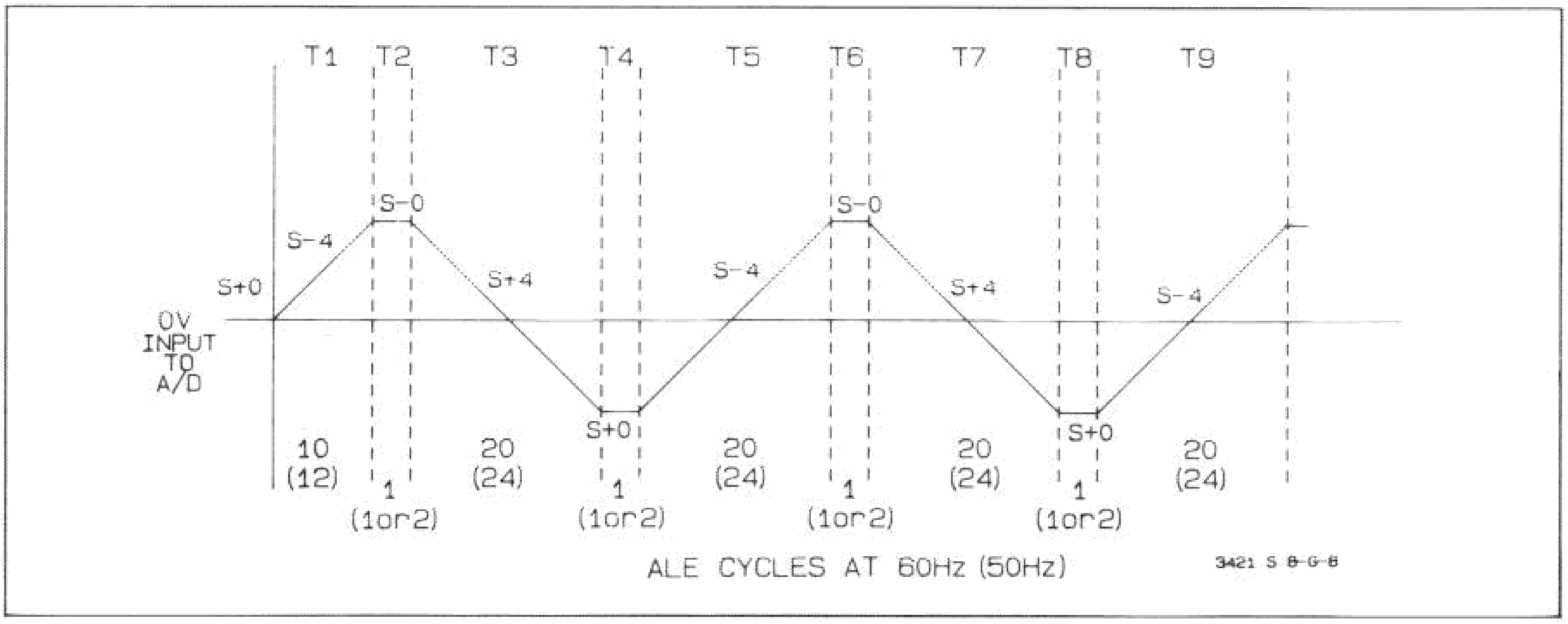



Figure 1-8-G-8. Runup Slopes For Zero Input (4½ Digit Mode)

**1-8-G-47. S+4 and S−4 Slope Generation.** The following explains how slopes S+4 and S−4 are generated.

**1-8-G-48. Slope S+4.** Refer to the schematic of Figure 1-8-G-9 for the S+4 slope generation. Notice that both the Y1 and Y2 paths are connected to ground. Since the summing node is a virtual ground, no current flows from ground to the summing node. Current does flow from the integrator capacitor through the 100kΩ resistor to +Vref. This generates a negative going output slope.

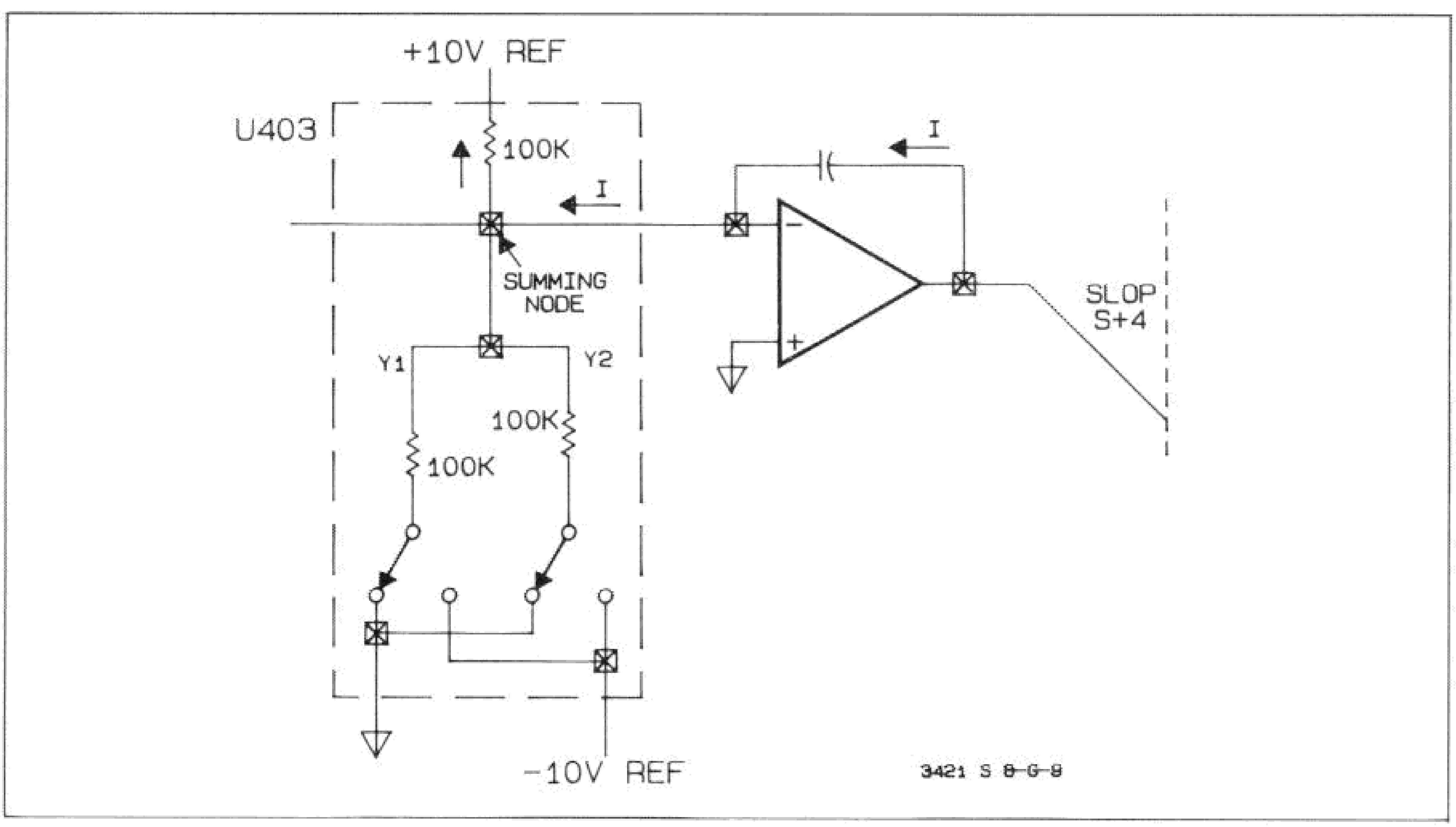



Figure 1-8-G-9. Slope S+4 Generation

**1-8-G-49. Slope S – 4.** Refer to the schematic of Figure 1-8-G-10 for the S – 4 slope generation. Notice that both Y1 and Y2 are connected to – Vref. Since the summing node is a virtual ground, current flows from – Vref, through Y1 and Y2, and through a 100kΩ resistor to + Vref. This current is generated because the parallel resistance of the two 100kΩ resistors in the Y1 and Y2 paths is smaller than the 100kΩ resistor connected to + Vref. The current through Y1 and Y1 divides equally at the summing node and flows to + Vref and charges the integrator capacitor. This results in a positive output slope.

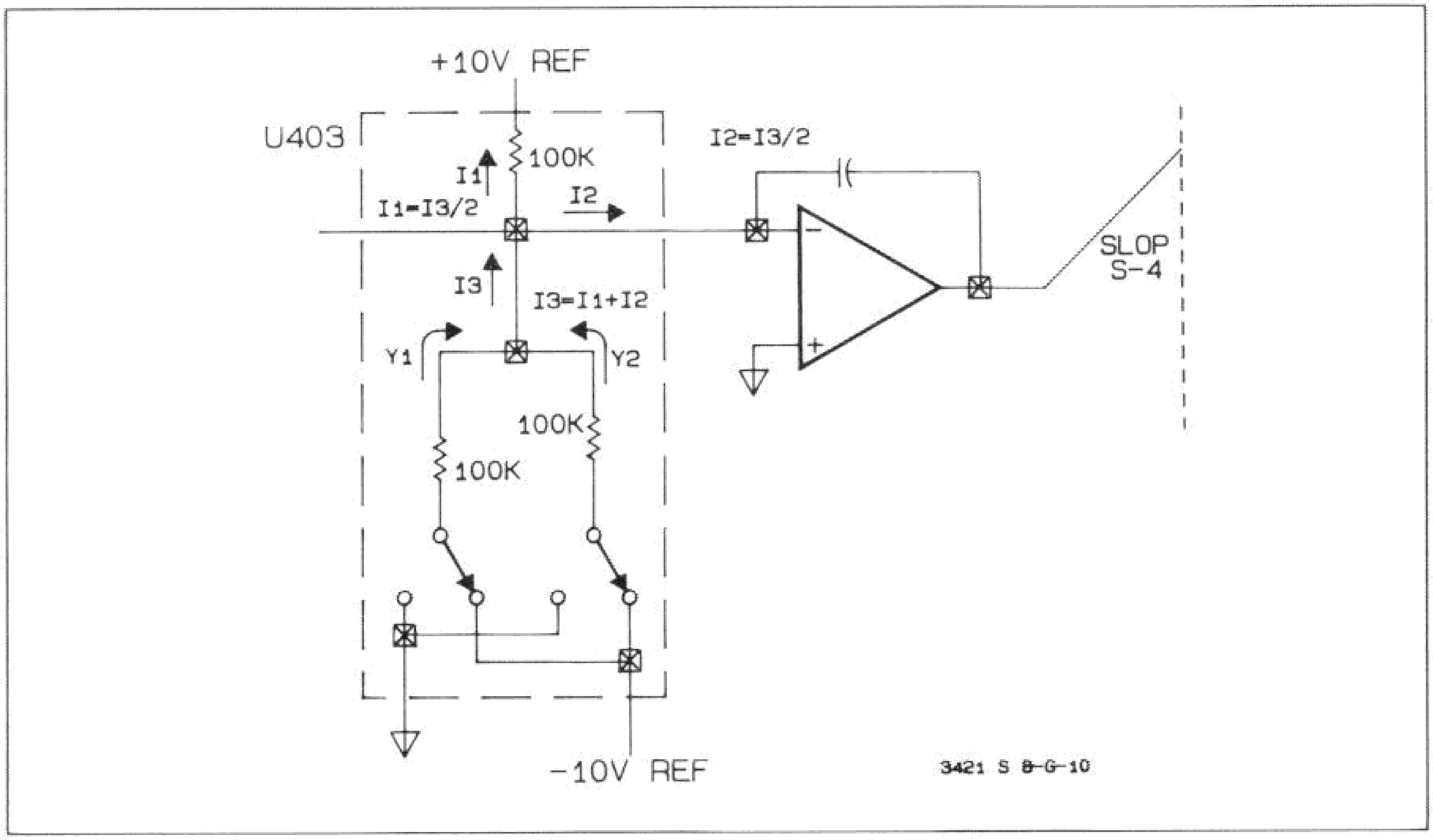



**Figure 1-8-G-10. Slope S–4 Generation**

**1-8-G-50. Slopes S + 0 and S – 0 Generation.** Refer to Figure 1-8-G-11 for the S + 0 and S – 0 slope generation. Notice that path Y1 connects + Vref to ground through two 100kΩ resistors, and path Y2 connects – Vref to + Vref through two 100kΩ resistors. In this configuration, current flows in the Y2 and Y3 paths from – Vref to + Vref through two 100kΩ resistors, and there is no current in the Y1 path. This results in zero volts at the negative input to the integrator (assuming there is no input voltage being applied), and therefore no charge is developed across the integrator capacitor.

1-8-G-51. For the next slope, Y1 is connected to – Vref and Y2 to ground. When this occurs, current ceases to flow in Y2 and now flows in Y1 and Y3 between – Vref and + Vref through two 100kΩ resistors. This again results in zero volts at the negative input to the integrator (with no input applied).

1-8-G-52. During the discussion on runup, it was explained that the S + 0 and S – 0 slopes were flat for a zero input. When an input voltage is applied, the S + 0 and S – 0 slopes will be proportional to the input voltage. S + 0 and S – 0 are essentially the same slope. The only difference is that paths Y1 and Y2 are switched when the slopes are switched (Y1 to ground and Y2 to – Vref, or Y2 to ground and Y1 to – Vref).

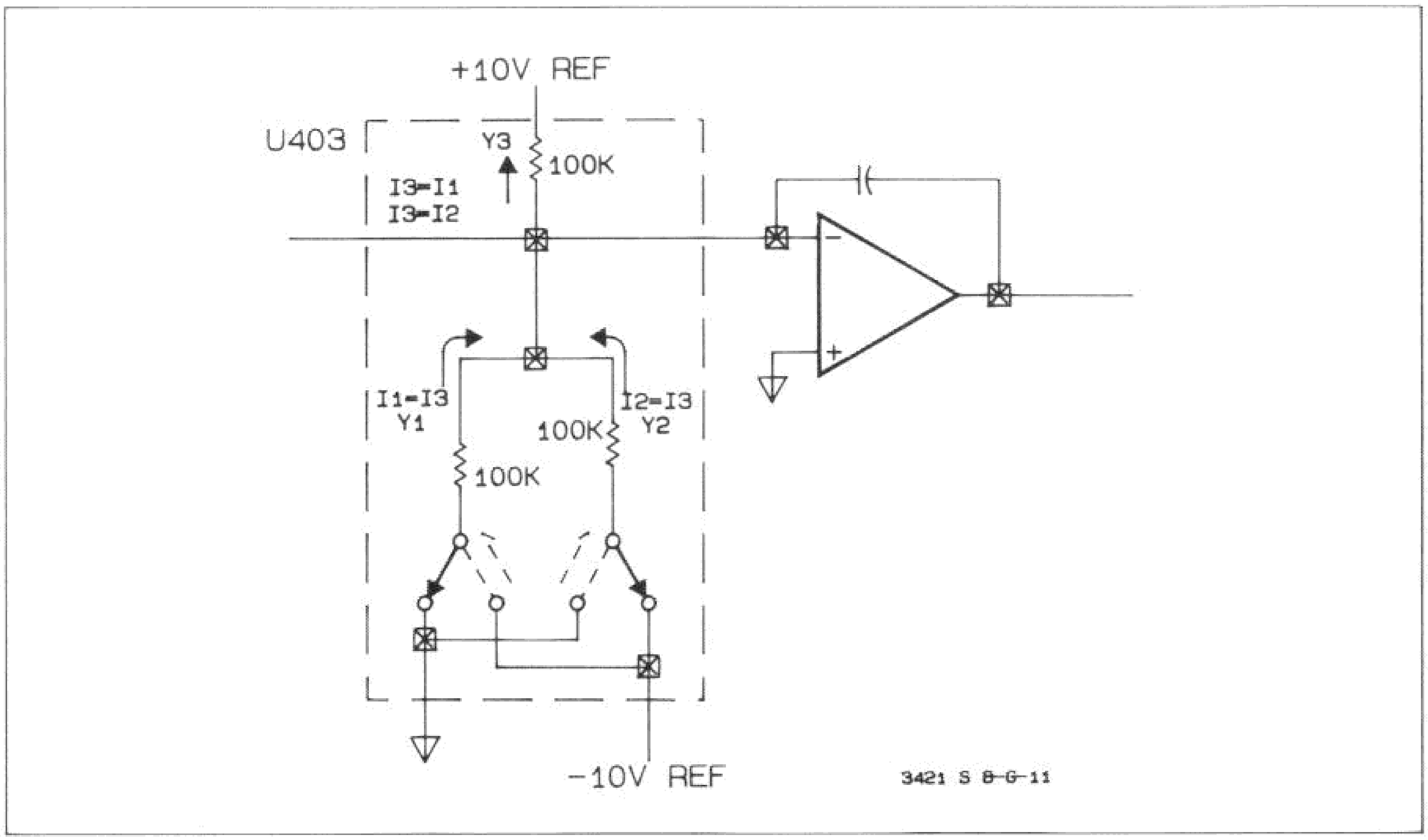



**Figure 1-8-G-11. Slope S+0 and S−0 Generation**

**1-8-G-53. Runup Time.** The runup time differs with the number of digits selected. For the 3½ digit mode, the runup time is 1/600 second for either 50 Hz or 60 Hz operation and is called 0.1 power line cycle (PLC). For 4½ digits, the time is 1/60 second (1/50 second for 50 Hz operation) and is called 1 PLC. The 5 ½ digit mode is different. In this mode, 1 PLC is used for the runup time, but it is repeated ten times. The ten readings are then averaged to obtain the reading.

**1-8-G-54. Digit Generation.** In the 4½ and 5½ digit modes, the two most significant digits are determined during runup. In the 3½ digit mode, only the first digit is determined. The three least significant digits are determined during rundown for all modes. A total of 5½ digits are developed for both the 4½ and 5½ digit modes. However, in the 4½ digit mode, the last digit is rounded off and only 4½ digits are displayed.

**1-8-G-55. Rundown.** When runup is completed, the input to the A/D is connected to ground for the rundown operation. Rundown is used to determine the three least significant digits of the reading.

1-8-G-56. When runup is complete, a charge remains on the integrator capacitor whose amplitude and polarity depends upon the last current applied (S + 4 or S − 4) and the input voltage. By obtaining the value of the remaining voltage the least significant digits of the reading can be determined. The voltage value is obtained by applying various currents to the integrator and counting the number of times the currents have to be applied for a zero crossing to occur.

1-8-G-57. The currents applied to the integrator during rundown are called the S – 4, S + 4, S – 3, S + 2, S – 1, and S + 1 currents. The resultant output slopes are the S – 4, S + 4, S – 3, S + 2, S – 1, and S + 1 slopes. These currents are applied in the order in which they are given (S – 4, S + 4, S – 3, etc.), with slope S – 0 applied between them. The only exception is the first S – 4 current applied when the voltage remaining across the integrator capacitor after runup is positive. The S – 4 and S + 4 currents have the same value as the S – 4 and S + 4 runup currents, but they are only applied half as long. During rundown, the S – 4 and S + 4 slopes are 10 ALE cycles long (as opposed to 20 ALE cycles during runup), and are called "half ramps".

1-8-G-58. Rundown consists of five time periods as shown in Figure 1-8-G-12. Refer to this figure for the following explantions.

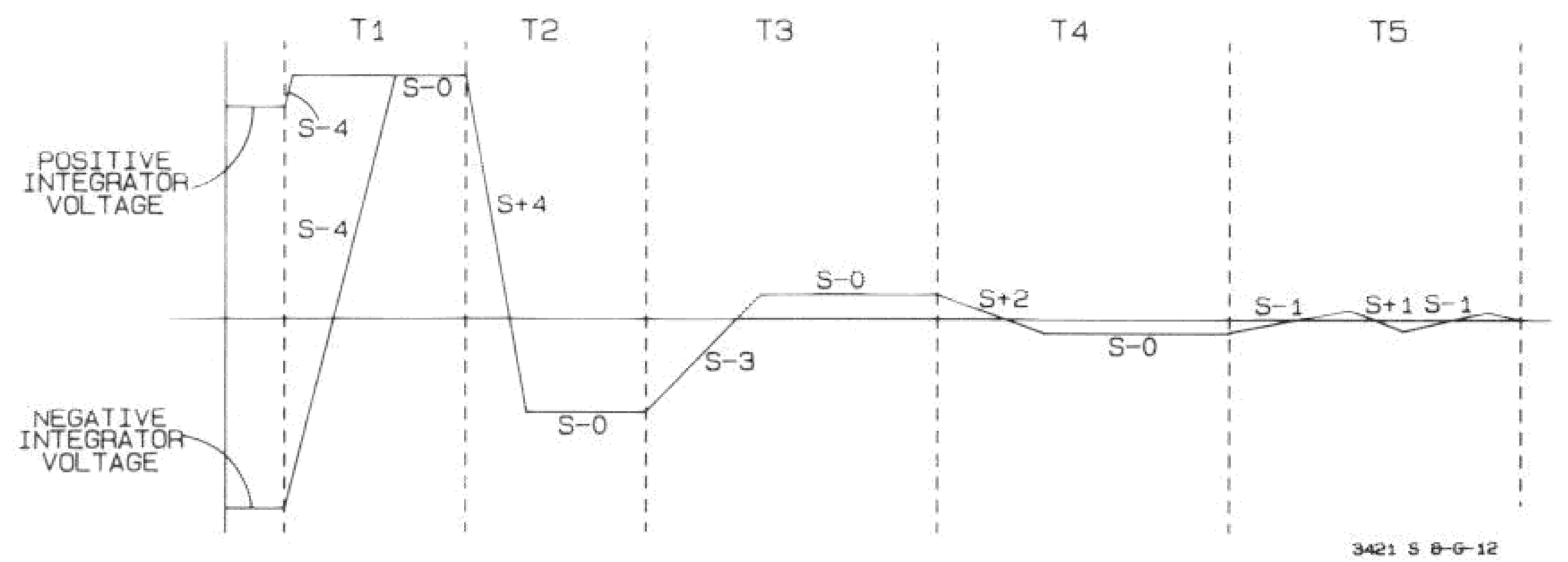



**Figure 1-8-G-12. Rundown Slopes**

1-8-G-59. When rundown starts, the CPU determines the polarity of the voltage remaining across the integrator capacitor from runup. It does this by checking the U403 comparator output (pin 11). If it is low, the voltage is negative; if it is high, the voltage is positive.

1-8-G-60. If the integrator voltage remaining after runup is negative, S – 4 is applied until a zero crossing occurs, with the restriction that it cannot be applied longer than three ramps. Normally this is long enough to cause a zero crossing to occur. When the zero crossing occurs, the comparator changes states, and S – 4 is removed within 10 ALE cycles of the zero crossing. If T1 is not completed when S – 4 is removed, a "no current" condition (S – 0) exists until the end of T1.

1-8-G-61. If the integrator voltage remaining after runup is positive, S – 4 is applied for a short period and then removed. The reason for this is because when the voltage left across the integrator capacitor is positve, applying S – 4 for a longer period could saturate the integrator. When S – 4 is removed, S – 0 is applied for the remainder of T1. Notice that S – 4 is applied first, regardless of whether the voltage across the integrator capacitor is positive or negative. This is to ensure that a zero crossing will occur for the S + 4 slope during T2 and the remaining slopes that follow.

1-8-G-62. S + 4 is applied at the beginning of T2. It has the same value as S – 4, but it has the opposite polarity. T2 has the same time period as T1, and S + 4 is allowed to be applied for a total of three ramps. Like S – 4, the S + 4 current is removed within 10 ALE cycles after a zero crossing occurs. When the S + 4 current is removed, a "no current" condition exists for the remainder of T2.

1-8-G-63. At T3, the S-3 current is applied to the integrator. S – 3 is 1/10 the value of the S – 4 current. The resultant slope is not as steep and it takes longer for a zero crossing to occur. Notice that T3 is longer than T1 or T2. The increased period of T3 allows the number of times S – 3 can be applied to be increased to seven, as opposed to three for S – 4 and S + 4. S – 3 is removed within 10 ALE cycles after a zero crossing occurs and a "no current" condition (S – 0) exists for the remainder of T3.

1-8-G-64. At T4, current S + 2 is applied. This current is 1/10 the value of the S – 3 current (or 1/100 of S – 4), and it has the opposite polarity. Like the S – 3 current, S + 2 is allowed to be applied up to seven times to cause a zero crossing. Once a zero crossing occurs, S + 2 is removed within 10 ALE cycles. When S + 2 is removed, a "no current" condition exists for the remainder of T4.

1-8-G-65. At T5, current S – 1 is applied. This current is 1/10 the value of S + 2, and it has the opposite polarity as well. S – 1 is applied until a zero crossing occurs and is then removed within 10 ALE cycles like the previous slopes. When S – 1 is removed, S + 1 is applied for 5 ALE cycles (one quarter ramp). S + 1 is applied instead of "no current" and only after the S – 1 current. S + 1 has the same value as S – 1 but the opposite polarity. After the zero crossing, S + 1 is removed within 5 ALE cycles. S – 1 is then applied for the duration of T5.

1-8-G-66. During rundown, a counter within the CPU counts the number of times S – 4, S + 4, S – 3, S + 2, S – 1, and S + 1 must be applied for the zero crossings to take place. This is used to calculate the three least significant digits of the reading.

**1-8-G-67. Integrator Offset Compensation.** The integrator can have offset errors which could prevent the S + 2 and S – 1 slopes from crossing zero. To make sure the slopes will cross zero, the digital to analog converter (R401 through R406) is turned on before the S + 2 currents are applied. This will null out any offsets from the integrator.

1-8-G-68. To find out how much the digital to analog converter (DAC) must correct for offset errors, the CPU checks the zero crossings during S + 1 and S – 1. Since these currents have equal amplitudes but opposite polarites, the zero crossings should occur at a certain time. If they do, no offset adjustment is required. If they do not, the appropriate offset current is applied just before the S + 2 current is applied during the next rundown. This is illustrated in Figure 1-8-G-13.

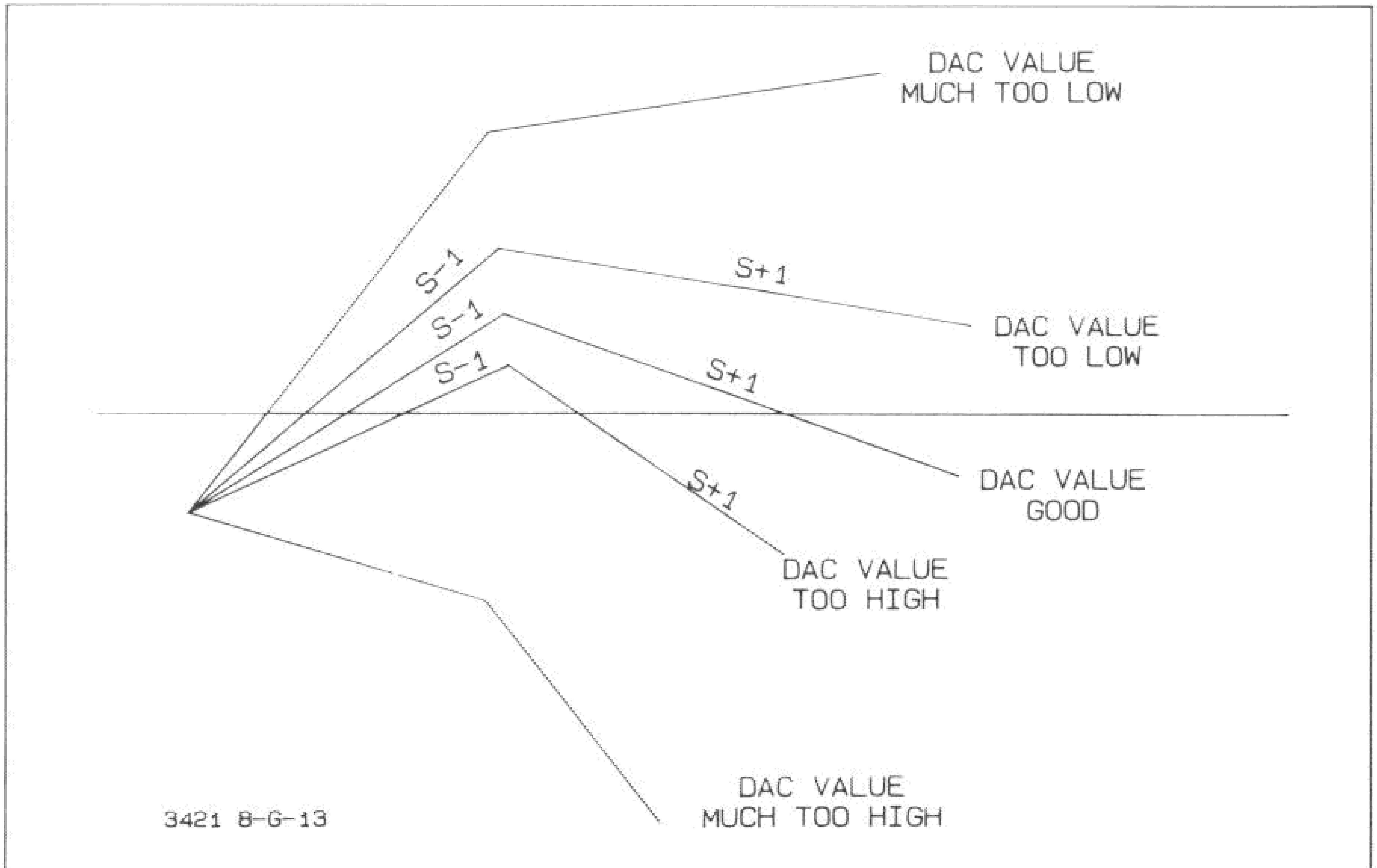



**Figure 1-8-G-13. Determining the DAC Setting**

**1-8-G-69. Rundown Slope Generation.** The S – 4 and S + 4 slopes are generated the same as they were for runup (see paragraph 1-8-G-47). The only difference is that they are not depen-dent on the input current, only on the S – 4 and S + 4 currents.

1-8-G-70. The S – 0 slope is generated the same way as it was during runup (see paragraph 1-8-G-50). The S – 3 and S – 1 currents use the same circuitry configuration as the S – 4 curr-rent during runup (see paragraph 1-8-G-49), but each has different resistor values. The resistor values are such that the S – 3 current is 1/10 the S – 4 current, and the S – 1 current is 1/1000 the S – 4 current. The S + 2 and S + 1 current use the same circuitry configuration as the S + 4 current during runup (see paragraph 1-8-G-48). In this case, the resistor values are such that the S + 2 current is 1/100 the value of S + 4 and S + 1 is 1/1000 the value of S + 4.

**1-8-G-71. A/D Converter and Reference Circuitry.** The A/D converter circuitry consists of the A/D hybrid (U403), A/D integrator (U401 and associated circuitry), and the CPU (U508). The – 10V voltage reference (CR401, U405, U404, and associated circuitry), and the + 10V voltage reference (U402 and associated circuitry) is considered part of the A/D converter. Refer to Schematic 1 for the following explanation of the A/D converter circuitry.

*a. A/D Hybrid (U403).* Refer to the block diagram of Figure 1-8-G-14 for the following explanations of the A/D hybrid.

1. The A/D hybrid contains various latches, decoders, and a clock generator. The decoders receive and decode control information from the CPU, and then passes it to the latches. The latches then transfer the new information to the various switches within the hybrid during each clock pulse. The clock pulses are generated by the clock generator which is synchronized by the ALE clock from the CPU.

2. The S − 4, S + 4, S − 3, S + 2, S − 1, S + 1, S − 0, and S + 0 currents are developed using resistors RA2 through RA10 in conjunction with the slope switches.

3. The input to the A/D comparator (inside U403) is connected to the integrator output. The comparator is enabled during the high level of the clock pulse from the internal clock generator. As the clock makes a high to low transition, the output of the comparator is latched, sent through a TTL driver to the CPU.

4. Depending upon the selected function, the hybrid takes an input directly from the input amplifier (for dc volts and ohms), or the ac to dc converter (for ac volts). The proper selection is made by switches inside the hybrid.

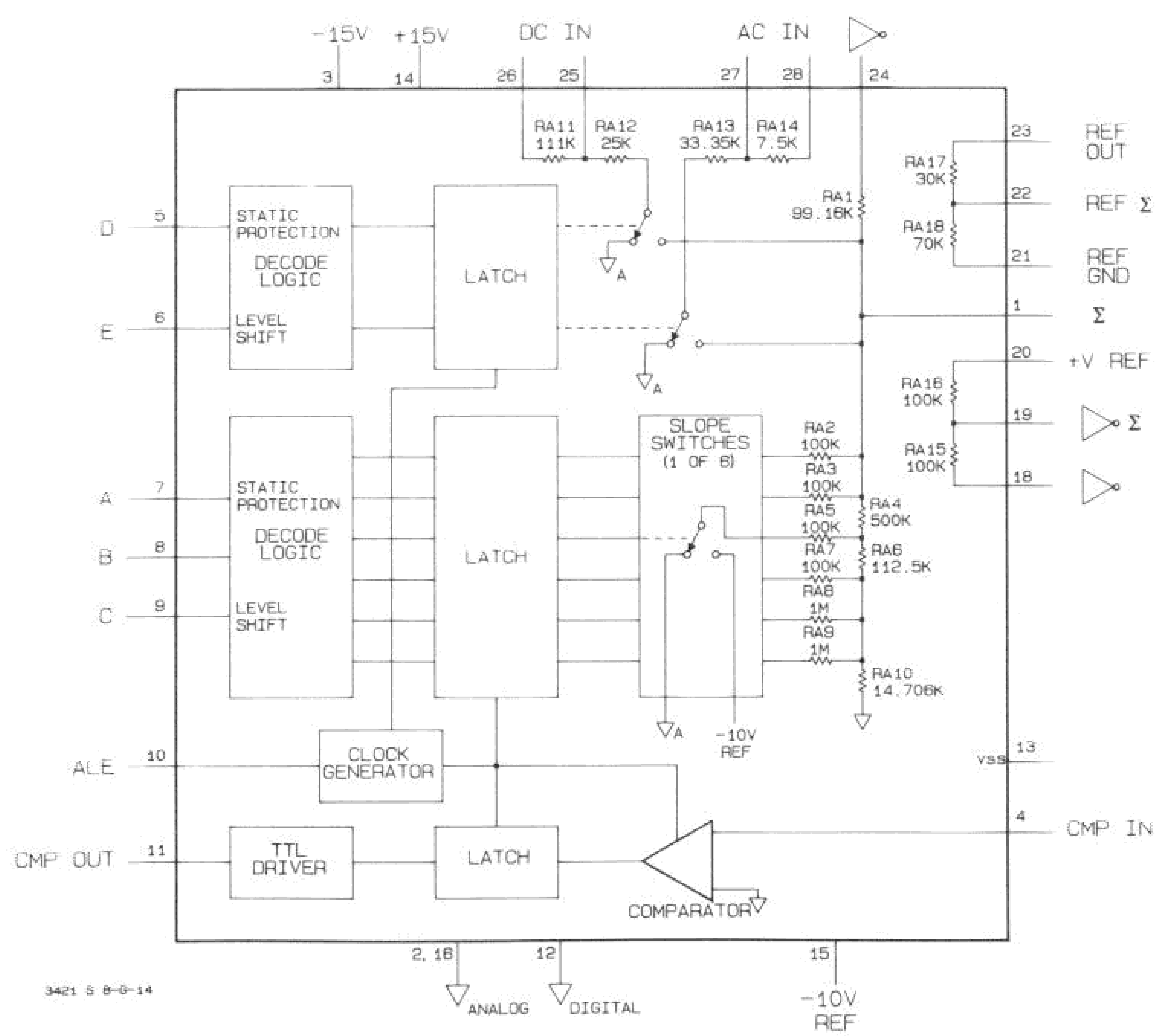



**Figure 1-8-G-14. A/D Hybrid (U403)**

*b. A/D Integrator (U401 and associated circuitry).* The A/D integrator consists of an amplifier (U401) with a feedback capacitor C410. The amplifier is configured as an inverting amplifier. Thus, the output slopes of the integrator will be positive for negative input currents and negative for positive input currents.

*c. CPU (U508).* The CPU controls the operation of the A/D converter and the instrument. This includes the runup and rundown operations and selecting the correct currents (S – 4, S + 4, etc.). The CPU is discussed in more detail in paragraph 1-8-G-74.

*d. Voltage References.* The voltage references provide three stable reference voltages: – 10V, + 10V, and a buffered – 10V. This circuitry is shown in Figure 8-G-15 and is explained as follows:

1. The – 10V reference voltage is used by the A/D hybrid (U403) to develop the S – 4, S + 4, S – 3, etc. currents. The – 10V is developed by amplifier U405, using feedback resistor R468 and zener reference diode CR401.

2. The buffered – 10V reference voltage is used by U403 as a – 10V power supply voltage. The voltage is developed by the U404 non-inverting amplifier, configured for a X1 gain. The U404 input comes from the U405 amplifier which supplies the – 10V reference.

3. The + 10V reference voltage is used by U403 (in conjunction with the – 10V reference) to develop the S – 4, S + 4, S – 3, etc. currents. The + 10V reference voltage is also used by the ohms current source to develop a stable ohms current (see paragraph 1-8-G-20). The + 10V is developed using inverting amplifier U403 and a 100kΩ feedback resistor inside U402.

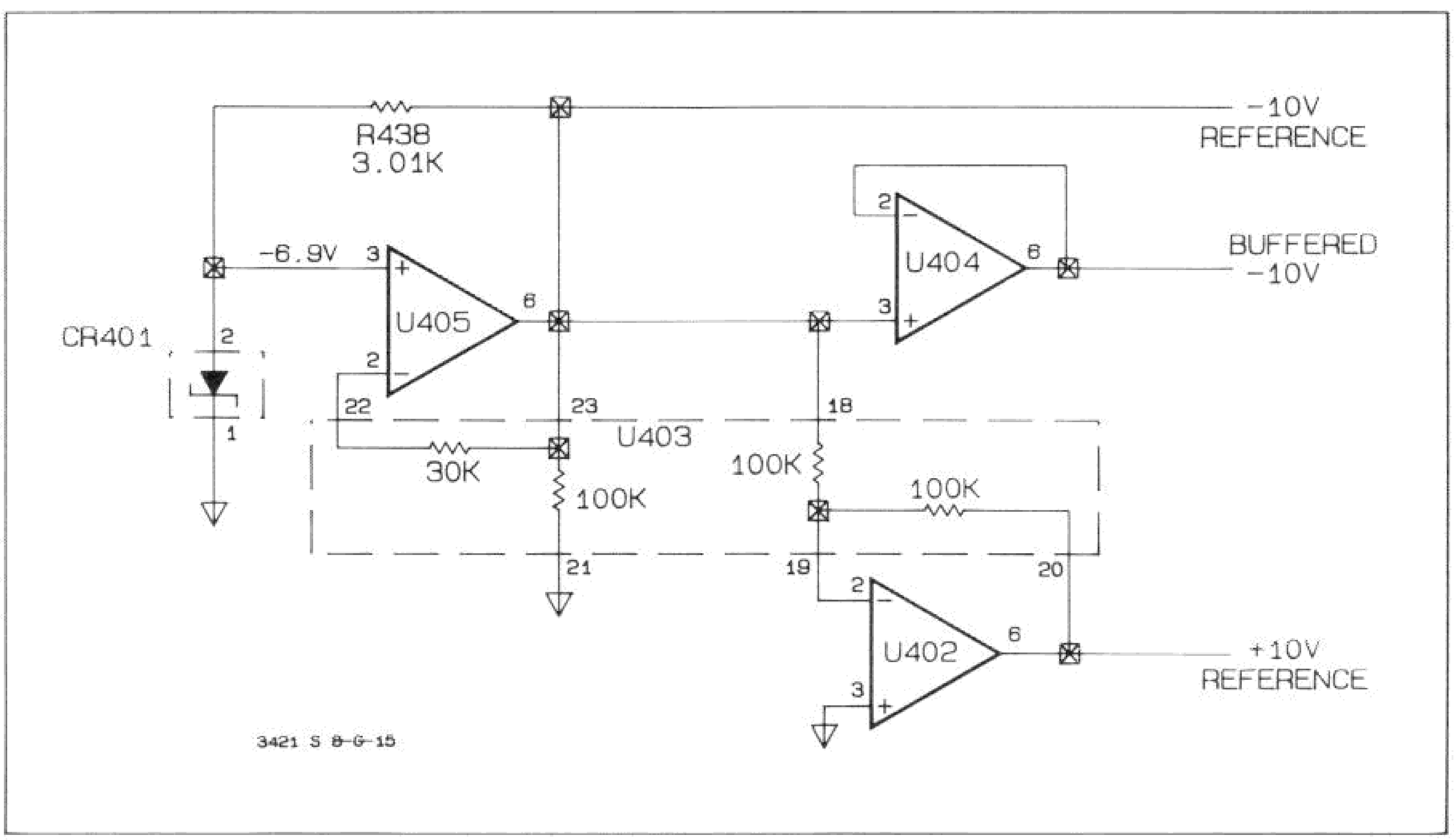



**Figure 1-8-G-15. Simplified Voltage Reference Circuitry**

### 1-8-G-72. Control Logic Circuitry.

1-8-G-73. This circuitry controls the operation of the entire instrument and primarily consists of the U508 CPU and two ROMs (U505 and U506). The operation of the control circuitry is described in the following paragraphs. Unless specified otherwise, refer to Schematic 2 for the explanations. The control circuitry is described as follows:

a. Main CPU (U508) Circuitry - paragraph 1-8-G-74.
b. ROM (U505, U506) - paragraph 1-8-G-76.
c. RAM - paragraph 1-8-G-77.
d. Port Expanders (U511, U512) - paragraph 1-8-G-85.
e. Power Down, Power Up, and Wakeup Logic - paragraph 1-8-G-87.
f. Reset Circuit - paragraph 1-8-G-90.
g. Counter (U581) - paragraph 1-8-G-92.
h. Display - paragraph 1-8-G-93.

**1-8-G-74. Main CPU (U508) Circuitry.** The CPU has an internal 128 bytes of RAM and a clock. The frequency and stability of the clock is controlled by the 6.003 MHz crystal (Y501). The CPU also has an 1-8-bit bus which serves as both an address and data bus, and two 1-8-bit ports. The CPU pin assignments are given in Table 1-8-G-2. The major CPU functions are explained starting with paragraph 1-8-G-75.

**1-8-G-75. Addressing.** The CPU can address up to 16k bytes of ROM by multiplexing the data bus (D0-D7) for the lower eight bits of address (A0-A7) and ports PT20-PT25 for the upper address bits (A1-8-A13). This extended addressing is required only for ROM. To address either the external RAM (XRAM) or calibration RAM (CAL RAM) requires only the multiplexing of the data bus to provide 1-8-bits of address (A0-A7). ROM and RAM are explained in the following paragraphs.

**1-8-G-76. ROM (U505, U506).** The HP 3421A uses two 64k bit NMOS ROMs. The ROMs are enabled when their respective EN (enable) line is low. U509 is used to gate PSEN (and PT25) to activate the appropriate ROM select line. If PT25 is high and PSEN is low, LEROM1 is active and U505 is enabled. If PT25 is low and PSEN is high, LEROM0 is active and U506 is enabled. The CE line to the ROMs are high unless a ROM is being read.

**1-8-G-77. RAM.** RAM exists in five chips. These are:

a. U508 CPU - 128 bytes
b. U504 XRAM - 256 x 4 bits
c. U503 XRAM - 256 x 4 bits
d. U502 CAL RAM - 256 x 4 bits
e. U501 HP-IL - 7 bytes

**1-8-G-78. XRAM.** U503 and U504 are used in parallel to create 1-8-bit words (one byte). U503 handles the most significant nibble (nibble is 4-bits) and U504 handles the least significant nibble. Both RAMs are backed up by the HP 3421A main battery.

1-8-G-79. The XRAM is used to store readings, channel lists, etc.. To read U503 and U504, the CPU activates the LRD and HEXR signal lines and specifies the RAM address to be read. The address is latched by the U507 address latch. The data contained at the specified address is then input to the CPU via the data bus.

**Table 1-8-G-2. CPU Pin Assignments**

| Pin # | Designation | Description |
|---|---|---|
| 34 | PT17 (HSC) | Part of slope select for A/D. |
| 33 | PT16 (HSB) | Part of slope select for A/D. |
| 32 | PT15 (HSA) | Part of slope select for A/D. |
| 31 | PT14 (HDC/CLK) | High Select DC/Clock for A/D. |
| 30 | PT13 (HRU) | High Run Up. This line is high during runup. |
| 29 | PT12 (SA1) | Signature Analysis (first level). This line is low when rear panel switch segment 1 is down. In early instruments (03421-66501 motherboard) this was switch segment 4. When SA1 is low at power on and then goes high, SA1 is entered. When in SA1, this port is used for the Start/Stop SA window. SA2, which is the second level of signature analysis, is entered after SA1 is running via switch segment 6. |
| 28 | PT11 (SD) | Serial Data to display and option boards. |
| 27 | PT10 (LPD) | Low Power Down. When this line goes low, the K700 relay will reset and thereby remove all circuit voltage except VBATT. LPD goes low when the front panel switch is pressed off, a loop power down is received, or the main battery voltage is low. |
| 38 | PT27 (CLK) | Clock for Display and Digital Option Boards. |
| 37 | PT26 (LEPXO) | Low Enable Port Expander 0. When low, port expander 0 (U512) is enabled. To enable port expander 1 (U511), this line is driven high, inverted by U510, to activate the LEPX1 signal. |
| 36 | PT25 (A13) | Address Line. When low, this line is gated to develop the enable line for ROMO (LEROMO); when high, this line is gated to develop the enable line for ROM1 (LEROM1). |
| 35 | PT24 (A12) | Address Line. This line selects which 4k block of ROM that gets accessed. |
| 24 | PT23 (A11) | Address Line. This line is used as a ROM address line or as a line to port expander U511 or U512. |
| 23 | PT22 (A10) | Address Line. This line is used as a ROM address line or as a line to port expander U511 or U512. |
| 22 | PT21 (A9) | Address Line. This line is used as a ROM address line or as a line to port expander U511 or U512. |
| 21 | PT20 (A8) | Address Line. This line is used as a ROM address line or as a line to port expander U511 or U512. |
| 25 | PROG | Port Expander Clock. When this line makes a high to low transition, PT20-PT23 to the port expanders has command data to be output. When this line makes a low to high transition, PT20-PT23 contains data to be read or written. |
| 9 | PSEN | Program Store Enable. PSEN is gated with PT25 to develop the ROM enable signals (LEROMO, LEROM1). |
| 6 | LINT | Low Interrupt. An active low signal that is activated by pressing the front panel switch off. When active, the CPU accesses a power down routine in ROM. |
| 8 | LRD | Read. An active low signal that the CPU activates to read the bus. |
| 10 | LWRT | Low Write. An active low signal that the CPU activates to write to the bus. |
| 11 | ALE | Address Latch Enable. A 400 kHz clock generated by the CPU. When ALE is high, the bus information is address which is latched when ALE makes a high to low transition. ALE is also used as a clock by the U403 A/D Hybrid. |
| 4 | RESET | Reset. When the line is low, the CPU is set to address 3000 Hex. |
| 1 | TO | Input from A/D comparator used to determine value of readings. |
| 39 | T1 | Input from Counter. |
| 12-19 | DO-D7 | A bi-direction bus used for both data and the lower 8-bits of the address. |
| 5 | SS | Single Step. This line is normally high via the output of U514 thereby disabling the single step function. |
| 20 | VSS | Circuit GND. |
| 26 | VDD | +5V. |
| 40 | VCC | +5V. |

1-8-G-80. To write to U503 and U504, the CPU activates the LWRT and HEXR signal lines, latches an address into the U507 address latch, and then sends data to the RAMs via the data bus.

1-8-G-81. The CAL RAM is used to store calibration constants. To write to this RAM, its write line is enabled by switching one of the rear panel switch segments to the down position. As long as the front panel switch is on, the CAL RAM receives its power from the main power supply. To ensure the calibration constants are not lost if the front panel switch is pressed off, battery BT501 is used as a backup.

1-8-G-82. The CAL RAM is addressed in the same manner as the XRAM (i.e., via the multiplexed data bus and U507 address latch). The data, however, is only 4 bits wide, as opposed to the 1-8-bit words of the XRAM.

**1-8-G-83. HP-IL RAM.** The eight bytes of RAM within the HP-IL chip are used to store HP-IL status. As data is received from the loop, it is transformer coupled through T501 and input to pins 17 and 18 of U501. The oscillator between pins 23 and 24 must be operative for this data to be clocked in. Pin 16 of U501 is an input for the power-on occurred mask which can be read and transferred to the CPU. Likewise, pin 15 indicates whether 50 or 60 Hz rejection is wanted.

**1-8-G-84. CPU RAM.** The 128 bytes of RAM within the CPU is used for internal bookeeping.

**1-8-G-85. Port Expanders (U511, U512).** The two port expanders are used in expanding the CPU's capability. The expanders receive their instructions via port PT20-PT23 and the PROG line. PT26 (pin 37) of U508 specifies the port expander to be selected. For a low at PT26, LEPX0 is high and selects U512. A high at PT26 is inverted by U510 and activates LEPX0 which selects U511.

1-8-G-86. Some of the port exander ports have pull-up resistors to ensure they are high at power on. Both port expanders have four 4-bit ports which can be used as inputs or outputs. The pinout for port expander 0 (U512) and port expander 1 (U511) is given in Table 1-8-G-3 and 1-8-G-4, respectively.

**1-8-G-87. Power Down, Power Up, and Wakeup Logic.** The HP 3421A uses latching type relays for input switching on the Multiplexer/Actuator Option and to switch power supply voltages. Provisions are made to to open closed relays when power down occurs.

1-8-G-88. The HP 3421A is designed so that whenever the front panel switch is off (out), the input switching relays (K101 and K103) and the power supply relay (K700) are reset, and any closed relay on an installed Multiplexer Option is opened. This action ensures that the input signal path is open. Anytime the front panel switch is off, HP-IL commands or messages will not be recognized. However, if a loop power down occurs, any closed relay on a Multiplexer Option will remain closed as long as the front panel switch is on. Also, if a loop power down has occurred, a power up will automatically occur when a new HP-IL frame is received, assuming the front panel switch is on when the frame is received.

Table 1-8-G-3. Pinout For Port Expander 0 (U512)

| Pin # | Designation | Function |
|---|---|---|
| 13 | PT70 | To R403 (Digital-to-Analog Converter). |
| 14 | PT71 | To R404 (Digital-to-Analog Converter). |
| 15 | PT72 | To R405 (Digital-to-Analog Converter). |
| 16 | PT73 | To R406 (Digital-to-Analog Converter). |
| 20 | PT60 (DATA) | This line, along with MODE and CLK, select the set/reset state of the appropriate relays depending upon the range and function selected. |
| 19 | PT61 (MODE) | This line, along with DATA and CLK, select the set/reset state of the appropriate relays depending upon the range and function selected. |
| 18 | PT62 | To R401 (Digital-to-Analog Converter). |
| 17 | PT63 | To R402 (Digital-to-Analog Converter). |
| 23 | PT51 (SA2) | Signature Analysis (second level). This line is active when the rear panel switch segment 6 is in the down position and a specified sequence of events take place (see Service Group E). |
| 22 | PT52 (LLB) | Low Low Battery. An active low input from the power supply that indicates the main battery is low. |
| 21 | PT53 (LBS01) | Input that, along with LBS02 and DI0, indicates what type of Option Board in slot 0. |
| 2 | PT40 (LEPIL) | Low Enable HP-IL Chip. An active low signal that enables the HP-IL chip. |
| 3 | PT41 (HEXR) | High Enable XRAM. An active low signal that enables the XRAM. |
| 4 | PT42 (HECAL) | High Enable CAL RAM. An active high signal that enables the CAL RAM. |

Table 1-8-G-4. Pinout For Port Expander 1 (U511)

| Pin # | Designation | Function |
|---|---|---|
| 19 | PT61 (A0) | Slot 0 Option Card Control. |
| 18 | PT62 (B0) | Slot 0 Option Card Control. |
| 17 | PT63 (A1) | Slot 1 Option Card Control. |
| 13 | PT70 (B1) | Slot 1 Option Card Control. |
| 14 | PT71 (A2) | Slot 2 Option Card Control. |
| 15 | PT72 (B2) | Slot 2 Option Card Control. |
| 16 | PT73 (DOE) | Option Card Control. |
| 20 | PT53 (LOAD) | Load Display. |
| 21 | PT52 (LBS22) | Input that, along with LBS21 and DI2, indicates the type of Option Board in slot 2. |
| 22 | PT51 (LBS21) | Input that, along with LBS22 and DI2, indicates the type of Option Board in slot 2. |
| 23 | PT51 (LBS12) | Input that, along with LBS11 and DI1, indicates the type of Option Board in slot 1. |
| 1 | PT50 (LBS11) | Input that, along with LBS12 and DI1, indicates the type of Option Board in slot 1. |
| 5 | PT43 (LBS02) | Input that, along with LBS01 and DI0, indicates the type of Option Board in slot 0. |
| 4 | PT42 (DI2) | If a Digital Option Board occupies slot 2, this is an input from the option. If another type of Option Board is in slot 2, this line, along with LBS21 and LBS22, indicates the type of Option Board available. |
| 3 | PT41 (DI1) | If a Digital Option Board occupies slot 1, this line is an input from the option. If another type of Option Board is in Slot 1, this line, along with LBS11 and LBS12, idicates the type of Option Board available. |
| 2 | PT40 (DI0) | If a Digital Option Board occupies slot 0, this is an input from the option. If another type of Option Board is in slot 0, this line, along with LBS01 and LBS02, indicates the type of Option Board available. |

1-8-G-89. There are three different conditions that should help in understanding power down, power up and relay openings. These are as follows:

*a. Condition 1.* Multiplexer Option installed, a channel is closed, and the front panel front panel switch is pressed off. This is a manual power down.

1. When the switch is pressed off, it causes the CPU interrupt (LINT) line to go low. Since LINT can only be generated by pressing the front panel switch off, the CPU knows that a manual power down is occurring and is programmed to open all relays before power is removed. The CPU accesses ROM for the routine it needs to open the option relays and to generate the LPD signal.

2. While the switch is off, the logic circuitry will not respond to any HP-IL command or message, including a power up command.

*b. Condition 2.* Multiplexer Option installed, a channel is closed, and a loop power down command is received over HP-IL.

1. When the loop power down command is received, the CPU does not open closed relays as it does when a manual power down occurs. In this situation, the CPU stores the status of actuator and scanner channels in XRAM, and then activates the Low Power Down (LPD) signal.

2. LPD is a signal which causes the K700 power supply relay to reset, thereby removing all power from the instrument except VBATT. VBATT is used to supply power to the XRAM and the Wakeup Logic during a loop power down. Prior to sending LPD, the CPU checks its actuator and scanner channel status and stores it in the XRAM. As long as the front panel switch is on, and a low battery does not occur, the instrument will wake up when a frame is received over HP-IL. The loop power up sequence is explained in the next two steps.

3. Whenever the instrument is in the sleep mode (which results from a loop power down) and a frame is received over HP-IL, a signal is gated which will activate the LPU signal. LPU causes the K700 relay to set and thereby restore power to the instrument.

4. When power is restored, the RESET line of the CPU is pulled low (see paragraph 1-8-G-90). This causes the CPU to go to address 3000 Hex. Since it is now in a Reset state, it must input its actuator and scanner channel status that was stored in the XRAM prior to power down.

*c. Condition 3.* Multiplexer Option installed and a loop power down is received over HP-IL. After power down has occurred, the front panel switch is inadvertantly pressed off.

1. In condition 1, it was explained that relay closures are not maintained when the front panel switch is off. Therefore, when the switch is inadvertently pressed off, circuitry is provided which allows the CPU to open all relays, even if a loop power down is in effect.

2. For this condition, pressing the switch off causes a momentary pulse to be gated through U531. This activates LPU, which in turn restores power long enough for the CPU to open all relays. After the relays are opened, power is then removed. As long as the switch is off, HP-IL commands will not be recognized. If, however, the front panel switch is pressed on again, messages from HP-IL will be recognized. However, the HP 3421A would, under these circumstances, be in a power on state, and would have lost its actuator and scanner channel information which it had stored in XRAM.

**1-8-G-90. Reset Circuit (U514 and Associated Circuitry).** The Reset Circuit causes the RESET line of the CPU to be pulled low when a power up occurs as a result of the front panel switch being pressed on or a loop power up occurs.

1-8-G-91. Notice that a Reset takes place when a power up occurs, regardless of how it occurs (loop power up or front panel switch). Thus, the CPU always wakes up in a Reset state. When it wakes up, it always checks the XRAM to see what actuator and scanner channel status it is supposed to have. If the power on resulted from the front panel switch being pressed on, the XRAM will contain no actuator and scanner status information. If, however, power is restored as a result of a loop power up, the CPU will have stored its actuator and scanner status information in the XRAM before it directed the power supply to remove power. This permits the instrument to assume the same actuator and scanner channel status it had before the loop power down occurred.

**1-8-G-92. Counter (U581 and Associated Circuitry).** The input to this circuitry is capacitive coupled from the input amplifier. The output of this circuit is routed to the T1 input of the CPU. This allows the CPU to count events over a specified period and thereby compute the frequency. Another use of the counter circuitry is the totalize function, where the number edges (rising or falling) can be counted.

**1-8-G-93. Display.** The display is a liquid crystal type which has four input lines: +5V, GND, Serial Data (SD), and a clock. Data is is serially written to the display by the CPU. The clock line, also generated by the CPU, clocks in the serial data.

1-8-G-94. The display indicates the power on/off state of the instrument, active channels on installed options, and error conditions. At power on, it also indicates any self test failures, and the HP-IB address if the HP-IB option is installed.

### 1-8-G-95. HP-IL OPERATION

1-8-G-96. All interfacing between the CPU and the HP-IL (Hewlett-Packard Interface Loop) is performed by the HP-IL chip (U501) and transformer T501. The transformer transfers information between the HP-IL and the HP-IL chip. The circuitry operation is as follows:

a. The HP-IL chip generates its own clock signal using internal circuitry in conjunction an external LC tank circuit that is comprised of L501 and C503.

b. The CPU addresses U501 by activating the LPIL line. If the operation is a write operation, the CPU activates the LWRT line. Depending upon the state of address lines A0-A2 (pins 3, 4, and 5 of U501), U501 interprets data sent to it from the CPU as the interface state (talker, listener) or a frame of data to be sent.

c. When U501 is enabled and its RD line is low (LRD active), it can send data to the CPU over the data bus. Depending upon the status of A0-A2, the data may be a frame that was received from the HP-IL, or status about the state of the interface.

d. The CPU continuously checks and updates U501 for incoming HP-IL data.

e. In early instruments (03421-66501 motherboard), there were several additional components used in the HP-IL circuitry see schematic in Section VII. These components were primarily used for filtering and overvoltage protection in early instruments.

## 1-8-G-97. REAR PANEL SWITCH

1-8-G-98. The rear panel switch has eight segments. Accessible from the rear panel are the segments for Power On SRQ (segment 3), 50Hz or 60Hz line rejection (segment 5), and Calibration RAM Write Enable (segment 8). Other switch segment used are for signature analysis (segments 1 and 6). In early instruments (03421-66501 motherboard) switch segment 4 was used instead of switch segment 1). The remaining switch segments are not used.

## 1-8-G-99. POWER SUPPLY

1-8-G-100. The power supply receives its power from either the +6V main battery (BT701) or the ac line. The power supply circuitry generates the following voltages:

+5V
+15V
−15V
VB (same as VBATT but switched)
VBATT (same as VB but unswitched)

**1-8-G-101. Line Voltage Selection.** There are four terminal posts on the primary side of the transformer that are used to select the proper line voltage. This is done by pressing a connector onto the terminal which corresponds to the line voltage that will be used. The ac line voltage that can be selected are as follows:

| Line Voltage | Terminal |
|---|---|
| 86-106 Volts | 100 |
| 104-127 Volts | 120 |
| 190-233 Volts | 220 |
| 208-250 Volts | 240 |

1-8-G-102. The main battery is always being charged when the power cord is plugged into the appropriate ac outlet (assuming that the battery and ac line fuses are installed). The battery charge rate, however, depends upon whether or not the HP 3421A power switch is on, and the type of circuit operation being performed. The maximum charge rate occurs if the power cord is plugged into an ac outlet and the front panel switch is pressed off.

1-8-G-103. When the main battery is fully charged, it supports portable operation for approximately 12 hours if the HP 3421A is equipped with HP-IL, or for approximately 6 hours if the Model HP 3421A is equipped with optional HP-IB. A discharged battery (<5.8V and >1V) can take about 16 hours to obtain a full charge if the front panel switch is off. If the front panel switch is on, it can take about 21 hours to obtain a full charge.

1-8-G-104. The main battery is independent of the CAL RAM battery (BT501). The CAL RAM battery provides power to the CAL RAM during power down to maintain the calibration constants stored in the CAL RAM. Thus, the CAL RAM battery is required only when the front panel switch is pressed off, or a loop power down command is received. The CAL RAM battery has a life of about five years and is not re-chargeable.

**1-8-G-105. Low Battery Detect.** This circuitry is shown in Figure 1-8-G-16. Its purpose is to generate the Low Low Battery (LLB) signal when the main battery is low. LLB goes active whenever VB drops to below 5.8V.

1-8-G-106. When LLB goes active, the instrument requests service from the system controller and turns on the error indicator in the display. Then, after approximately three minutes, the HP 3421A will power down. Executing commands during the three minute period will vary the actual time of power down. During this three minute period, the instrument will execute all commands sent to it except for the following:

TOTalize [channel number]
Monitor High <digital bit>
Monitor Low <digital bit>
MoNitor <slot number>
Digital Trigger <digital channel>

1-8-G-107. Once the instrument powers down as a result of a low battery, the front panel switch must be cycled after the battery is re-charged. Unless this is done, the power supply wakeup logic will be disabled.

1-8-G-108. If a low battery is detected at power on, display segment 27 and the error indicator turn on followed by an instrument power down three seconds later.

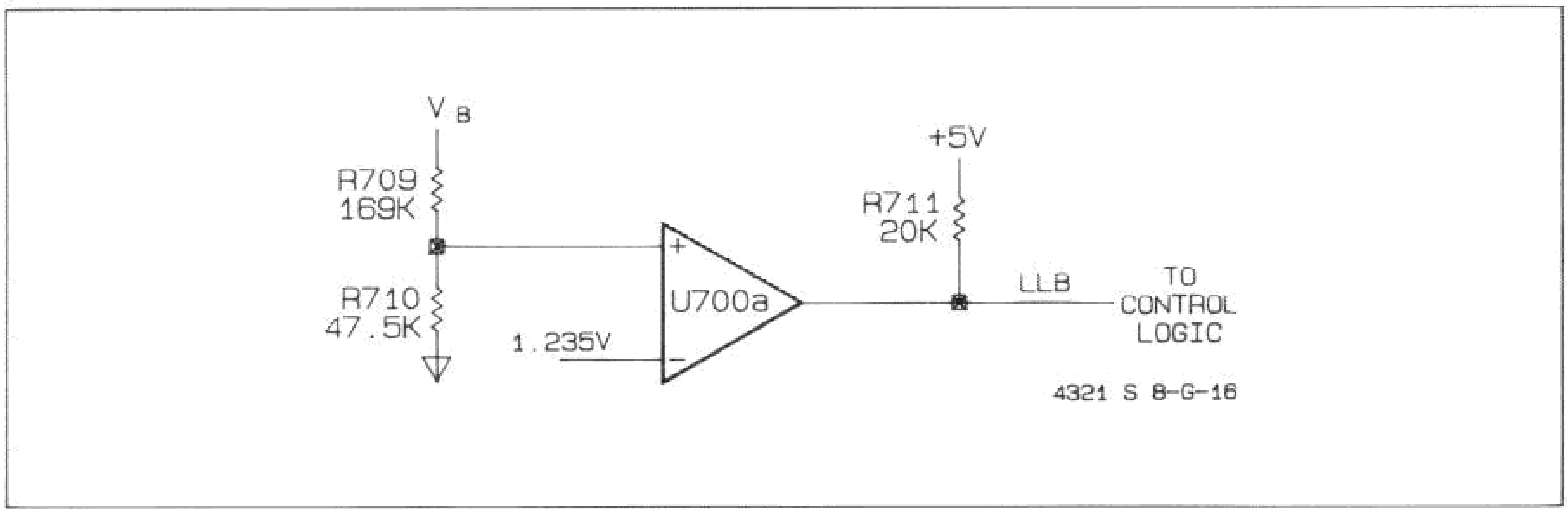



**Figure 1-8-G-16. Low Battery Detect Circuit**

**1-8-G-109. Battery Charger.** The battery charger is a current limited, temperature compensated, voltage source. A simplified schematic of the battery charger circuit is shown in Figure 1-8-G-17. The circuit descripion is given in the following paragraphs.

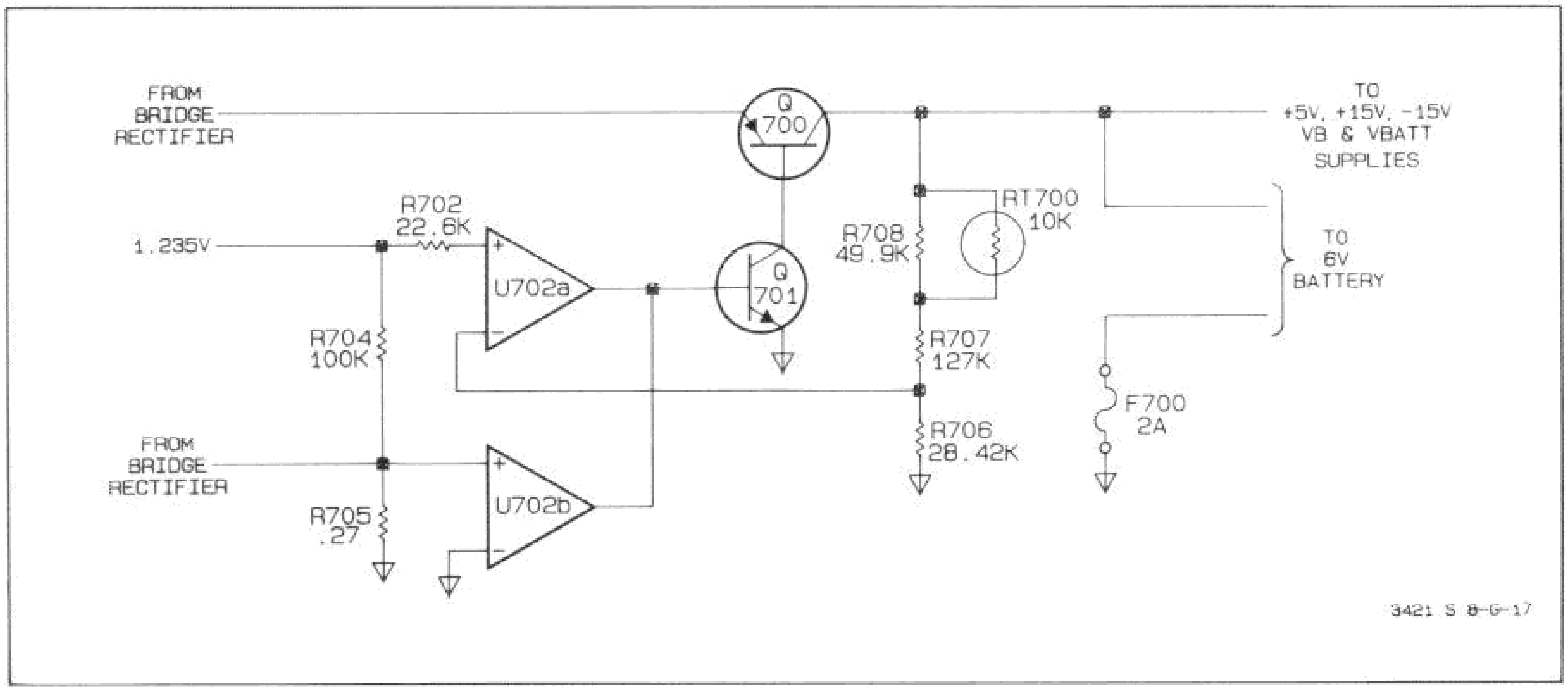



**Figure 1-8-G-17. Simplified Schematic Of Battery Charger**

1-8-G-110. When the battery charger is acting as a voltage source, U702A regulates the base current of Q701, which in turn controls the base current of Q700, and thus the output voltage. The output voltage is divided by R706, R707, R708 and RT700 and fed back to the negative input of U702A. If the output voltage is low, this feedback path increases the base drive to Q701. As Q701 turns on harder, Q700 provides more current to the load. If the output voltage is high, the feedback path to U702A causes the base drive to Q701 to be reduced, which reduces current to the load.

1-8-G-111. If the battery voltage is so low that the output voltage cannot be maintained without sourcing over .5 A, the battery charger circuit will act as a .5 A current source. The current being supplied is sensed by R705. When the voltage on the positive terminal of U702B is above ground potential, the sourced current is less than .5 A. However, if the potential at the positive terminal of U702B goes below ground, U702B will reduce the base drive of Q701 and therefore reduce the current output of the battery charger circuitry.

**1-8-G-112. +5V Regulation.** The +5V is regulated by a portion of the circuitry shown in Figure 1-8-G-18. When a load draws excessive current which causes the +5V to decrease, the decrease is felt at the junction of R723 and R724. This causes the ouput of the U700C comparator to go high, which causes Q703 to turn on. When Q703 turns on, more drive is provided for Q702, providing more current to the load.

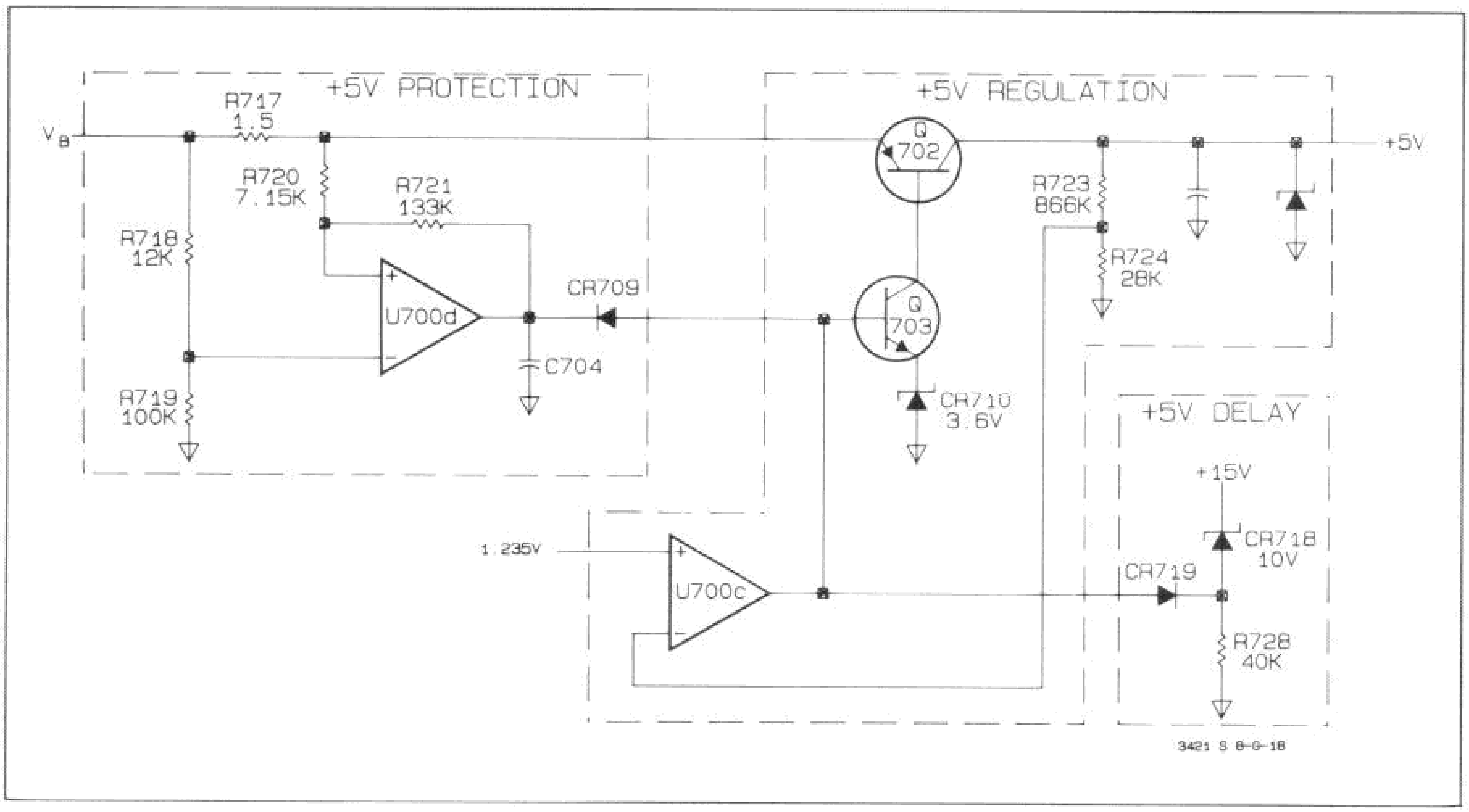



**Figure 1-8-G-18. Simplified Schematic Of The +5V Regulation, +5V Protection, and +5V Delay Circuit**

**1-8-G-113. +5V Protection.** This circuit is shown in Figure 1-8-G-17. It's purpose is to detect the current that is drawn from the +5V supply, and turn the supply off if excessive current is drawn. This is explained in the following paragraph.

1-8-G-114. Current through the load flows through a 1.5Ω current sense resistor (R717). When the load current is not excessive, the output of U700D is at a high impedance state. If the load current is high enough, the voltage drop across R717 will cause positive input of U700D to be less than the negative input, which makes the U700D output go low. This causes Q703 to turn off, which also causes Q702 to turn off. When Q702 turns off, the +5V supply will not supply current to the load.

1-8-G-115. R721 provides positive feedback to the positive input to U700D to ensure that when maximum current to the load is reached, the +5V supply will turn off. When a load draws enough current to cause the +5V supply to turn off, the positive input to U700D will again go higher than the negative input. The ouput, however, will stay low until C704 charges (~100 ms). If the excessive load has disappeared, the +5V will stay on; if the load is still there, the +5V will turn off again.

**1-8-G-116. +5V Delay Circuit.** This circuit is shown in Figure 1-8-G-18. Its purpose is to keep the +5V supply off until the +15V supply has reached at least +13 volts. This prevents damage to to the +5V supply if it is accidently shorted to +15V. Whenever the +15V supply is greater than +13V, CR719 is reversed biased and there is no effect on Q703. Whenever the +15V supply is less than +13V, CR719 is forward biased causing the Q703 base current to be shunted to ground via R728. This will not allow the +5V supply to turn on.

**1-8-G-117. −15V and +15V Generation.** These two voltages are generated from VB (~ +6V) by the switching regulated portion of the power supply. Refer to the simplified schematic of Figure 1-8-G-19 for the switching power supply operation.

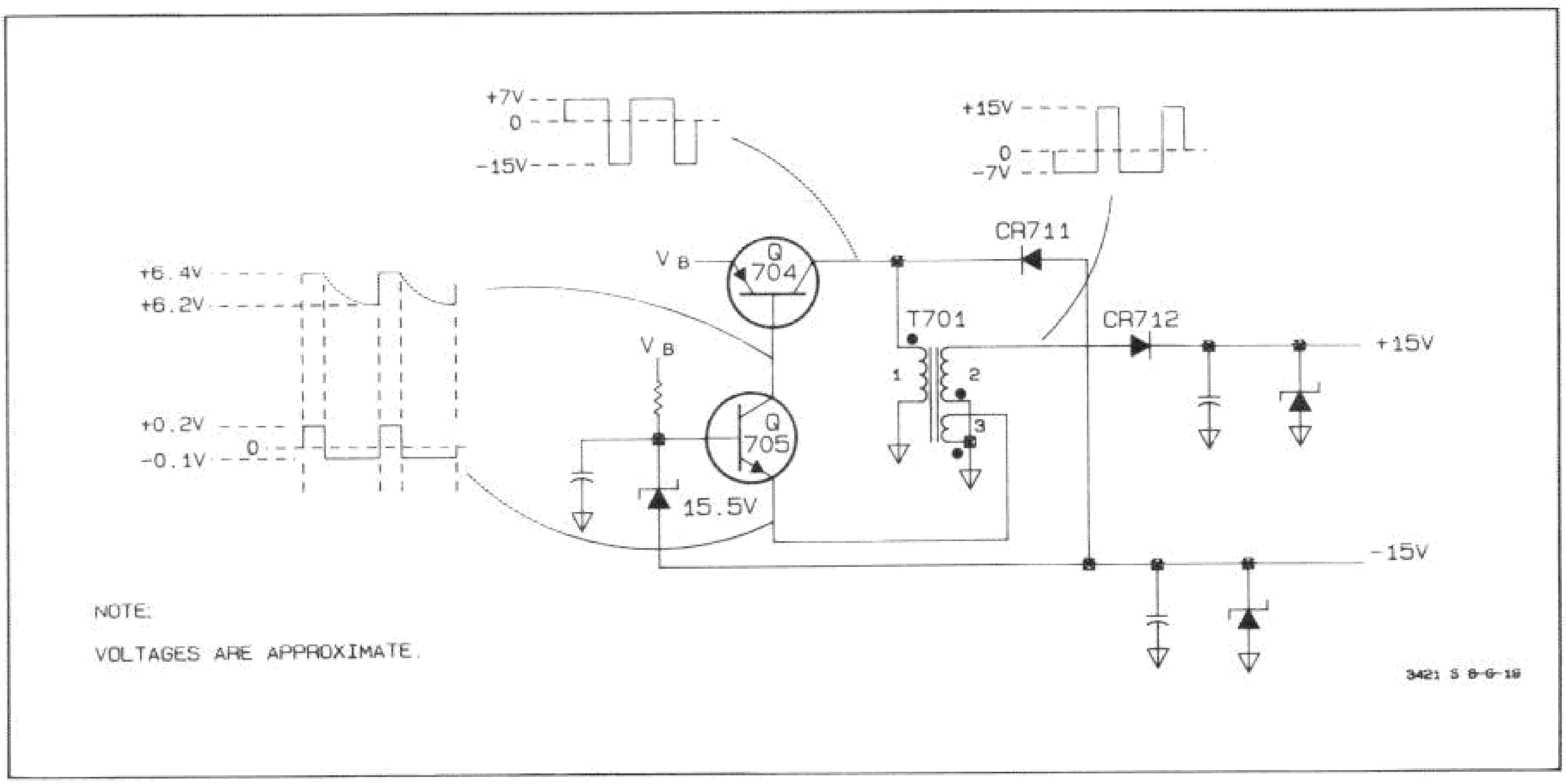



**Figure 1-8-G-19. Schematic Of The Switching Power Supply**

1-8-G-118. At turn on, the capacitor at the base of Q705 act like a temporary short which keeps Q705 turned off. As the capacitor charges, Q705 conducts which turns on Q704. With Q704 turned on, a magnetic field starts building up across the primary of T701 (1) which is induced into the two secondary windings (2 and 3). The emitter voltage of Q705 then goes from 0V to positive and turns Q705 off. When the magnetic field on T701 collapses, the Q705 emitter voltage then goes to zero. This turns Q705 on again.

1-8-G-119. As the field around secondary winding 2 collapses, CR712 conducts causing the capacitor associated with the +15V portion of the supply to charge. When the field around secondary winding 3 collapses, it causes a positive voltage to be applied to the emitter of Q705, causing Q705 to turn off. When Q705 turns off, it causes Q704 to turn off. At this time the field around the primary collapses, forward biasing CR711 and charging the filter capacitor associated with the negative portion of the power supply. Q705 and Q704 then turn on again and the cycle repeats.

1-8-G-120. It is the flyback energy of the transformer that generates the +15V and −15V. The −15V supply is used as the master regulator. That is, under a no load condition, the 15.5V zener diode which connects to the base of Q705, holds the base at about +.5V. If an excessive load causes the −15V supply to swing in a positive direction, the base of Q705 also swings in a positive direction, causing it to conduct longer, and thereby increase the current to the load.

1-8-G-121. The +15V portion of the supply is regulated only as a result of the regulation of the −15V supply. That is, if the +15V supply has an excessive load but −15V supply does not, the +15V can be loaded down. However, if the −15V supply has a load that is more than the +15V supply (or at least equal to it), both supplies can be regulated within 2% of each other. In the HP 3421A, the −15V supply has the largest load.

**1-8-G-122. Power Down Circuit.** This circuit is used to remove all power to the HP 3421A circuitry except for VBATT. A simplified schematic of this circuitry is shown in Figure 1-8-G-20, and is explained in the following paragraphs.

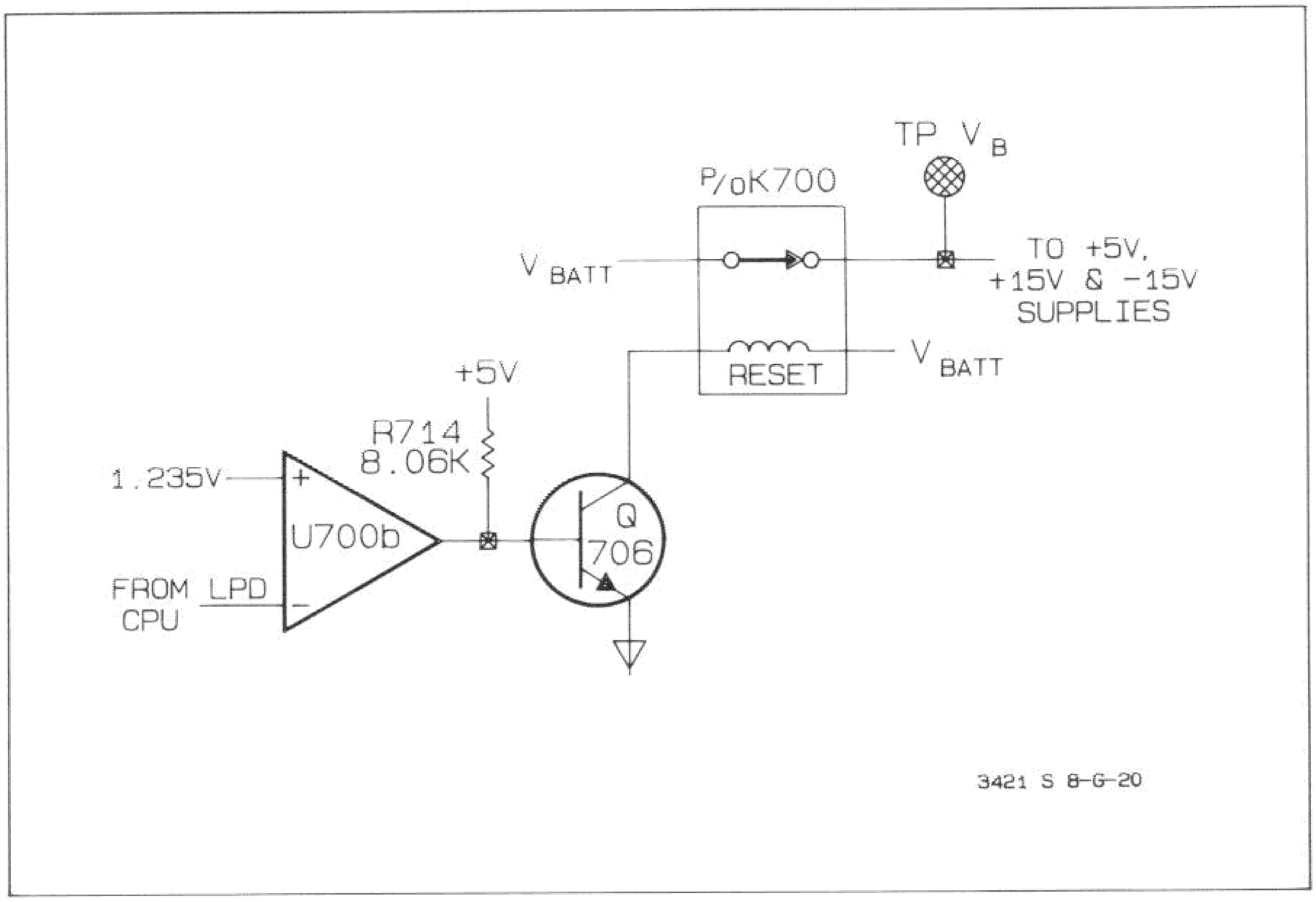



**Figure 1-8-G-20. Simplified Schematic Of Power Down Circuitry**

1-8-G-123. This circuitry is activated when the CPU sends the LPD (Low Power Down) signal. This occurs when the front panel switch is pressed off, or when a loop power down command is received. When LPD is asserted, the output of U700B goes high. This turns on Q706 which resets (opens) K700. Since K700 is a latching relay, once it is reset, it remains reset until the LPU (Low Power Up) signal causes it to set again. When K700 resets, power is removed from the +5V, +15V, and −15V supplies. VB is also removed. VBATT, however, is not removed. The only difference between VB and VBATT is that VB is switched in and out of the instrument circuitry by K700, while VBATT is always applied, regardless of the state of K700. VBATT is used in the wake up logic and at the D input of the U701B one-shot to activate the LPU (Low Power Up) signal which is explained next.

**1-8-G-124. Back-Up Power Down Circuit.** This circuit is used to back up the main power down operation explained in paragraphs 1-8-G-122 and 1-8-G-123. Its main purpose is to power down the HP 3421A if for some reason the CPU does not send the LPD signal. A simplified schematic is in Figure 1-8-G-21, and is explained in the following paragraph.

1-8-G-125. This circuit is activated when the LINT line is set low. This happens whenever the front panel switch is pressed off. The low LINT line then triggers one-shot U701A after a delay that is developed by a resistor and capacitor connected to the line. The reason for the delay is to give the main Power Down circuit a chance to operate. Remember, the back up circuit is only used if the LPD signal is not developed by the CPU to power down the instrument. After U701A is triggered, its Q output goes high and turns on Q708, which in turn resets K700. Here also, power is removed from the +5V, +15V, and -15V power supplies when K700 is reset.

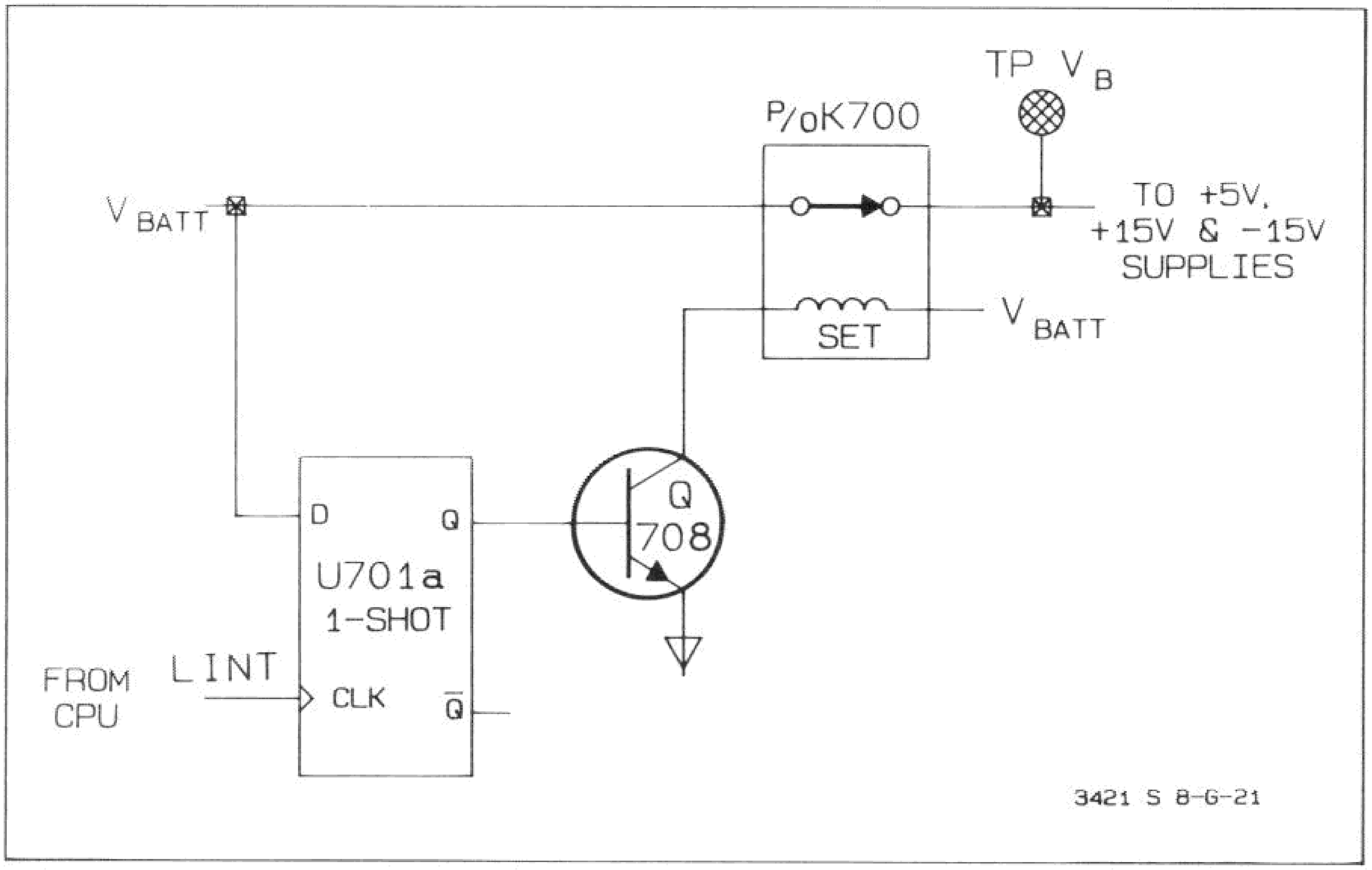



**Figure 1-8-G-21. Simplified Schematic of the Back-Up Power Down Circuitry**

**1-8-G-126. Power Up Circuit.** This circuit is used to restore VB, +5V, +15V, and −15V to the HP 3421A. A simplified schematic of the power up circuitry is shown in Figure 1-8-G-22 and is explained in the next paragraph.

1-8-G-127. This circuitry is activated when the CPU sends the LPU (Low Power Up) signal. This occurs when the front panel on/off switch is pressed on, or when a loop power up command is recognized. When LPU is asserted, it trigger the U701B one-shot multivibrator. This turns on Q707 which sets (closes) the K700 relay. When K700 is set, VB and power to the +5V and ±15V supplies is restored. As noted under the explanation for Low Power Up, K700 is a latching relay. Therefore, when it is set, it will remain set until it is again reset. This means that LPU and LPD need only be asserted for a short time to set and reset K700.

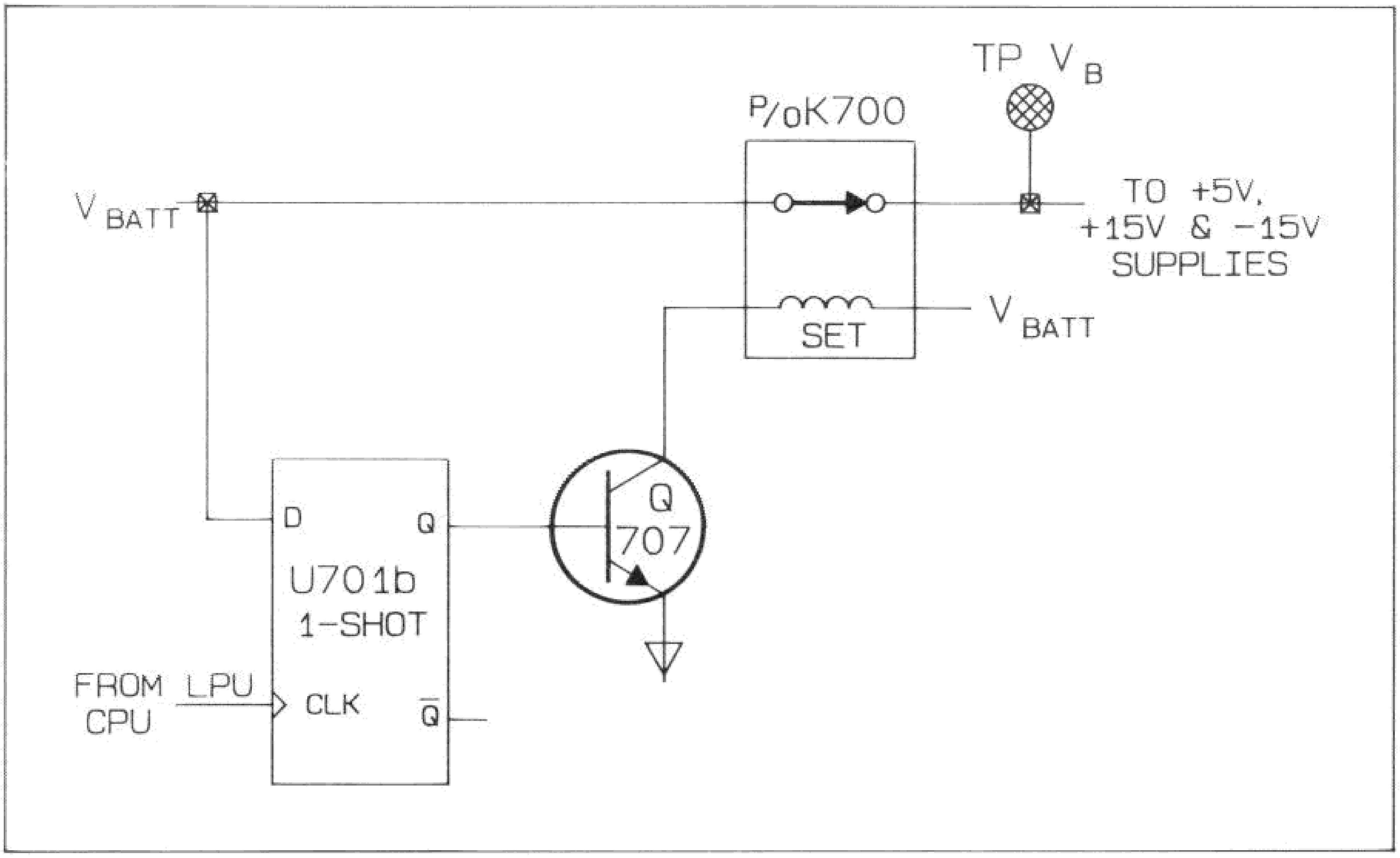



**Figure 1-8-G-22. Simplified Schematic of the Power Up Circuitry**

**1-8-G-128. Reset Switch.** This circuit is a master instrument reset. If the instrument is powered up and switch S700 is pressed in all power (except CAL BATT) is removed from the HP 3421A circuitry, including VB, VBATT, +5V, +15V and −15V. When S700 is released, power is restored to all devices. Typically, an instrument reset would be necessary if the HP 3421A gets hung up and will not respond to any commands.

# SERVICE GROUP H
# MNEMONIC TABLE, BLOCK DIAGRAM, COMPONENT LOCATOR, AND SCHEMATICS

## 1-8-H-1. INTRODUCTION

1-8-H-2. This service group contains a signal mnemonic table, detailed block diagram, component locator, and schematics.

## 1-8-H-3. Mnemonics

1-8-H-4. The signal mnemonics used on the schematics and other places in this manual are listed in Table 1-8-H-1.

**Table 1-8-H-1. Signal Mnemonics**

| Mnemonic | Definition | Origin |
|---|---|---|
| A0-A2 | These lines are set high to read from, or write to, digital options. | U511 pins 19,17,14, Schematic 2. |
| ALE | Address Latch Enable.<br>400 kHz output clock of U508. | U508 pin 11, CPU, Schematic 2. |
| B0-B2 | These lines are used by digital options to latch digital output data. Latching occurs on the rising edge. | U512 pins 18,13,15, Schematic 2 |
| DI0-DI2 | Digital Input. Serial data from digital options. | Digital Option Boards. |
| DOE | Digital Output Enable.<br>Enables Digital Outputs. | U511 pin 16, Schematic 2. |
| HCP | High Comparator Out. | U403 pin 11, Schematic 1. |
| HDC | High DC. | U508 pin 31, CPU, Schematic 2. |
| HDS2 | High Data Select. Used by digital options to specify serial or parallel mode. Serial mode is specified when HDS2 is 0 and parallel is specified when HDS2 is 1. | U512 pin 5, Schematic 2. |
| HECAL | High Enable Calibration RAM.<br>Enables Calibration RAM. | U512 pin 4, Logic Circuitry, Schematic 2. |
| HEXR | High Enable X RAM.<br>Enables X RAM. | U512 pin 3, Logic Circuitry, Schematic 2. |
| HRU | High Run Up. This line is high during run up. | U508 pin 30, Logic Circuitry, Schematic 2. |
| HSA | Part of slope select for A/D. | U508 pin 32, Logic Circuitry, Schematic 2. |
| HSB | Part of slope select for A/D. | U508 pin 33, Logic Circuitry, Schematic 2. |
| HSC | Part of slope select for A/D. | U508 pin 34, Logic Circuitry, Schematic 2. |
| LBS01/LBS02<br>LBS11/LBS21<br>LBS21/LBS22 | Low Board Select 01/02. These two lines identify the slot slot number and the type of option occupying a slot. | Option Boards. |

## Table 1-8-H-1. Signal Mnemonics (Cont'd)

| Mnemonic | Definition | Origin |
|---|---|---|
| LCWRT | Low Calibration RAM Write. This line can only be activated when the rear panel switch segment 8 is in the down position and the CPU is performing a write operation. This line allows the CAL RAM to be written to. This function is used for calibration. | S501 segment 8, Rear Panel Switch, Schematic 2. |
| LEPXO | Low Enable Port Expander 0. Enables Port Expander 0 (U512). | U508 pin 37, Logic Circuitry, Schematic 2. |
| LEPX1 | Low Enable Port Expander 1. This signal is used to enable Port Expander 1 (U511) and is active when LEPXO is high. | U510 pin 6, Logic Circuitry, Schematic 2. |
| LEROMO | Low Enable ROM 0. Enables ROM 0 (U506). | U509 pin 3, Logic Circuitry, Schematic 2. |
| LEROM1 | Low Enable ROM 1. Enables ROM 1 (U505). | U509 pin 11, Logic Circuitry, Schematic 2. |
| LINT | Low Interrupt. When low, this line causes the CPU to open any closed relays. This line can only be asserted when the front panel switch is turned "OFF". | Switch S502, Logic Circuitry, Schematic 2. |
| LLB | Low Low Battery. This signal is activated when the main battery voltage drops to <5.8V. | U700 pin 2, Power Supply, Schematic 3. |
| LPD | Low Power Down. A low signal generated by the CPU which causes the power supply to remove all power except VBATT and CAL BATT. Signal is activated when the front panel switch is turned "OFF", or a loop power down command is received. | U508 pin 27, Logic Circuitry, Schematic 2. |
| LPIL | Low Enable Interface Loop. Enable signal for HP-IL chip (U501). | U512 pin 2, Logic Circuitry, Schematic 2. |
| LPU | Low Power Up. This signal triggers the U701B one shot multivibrator which sets K700 and restores all power to the instrument. | U531 pin 3, Logic Circuitry, Schematic 2. |
| LRD | Low Read. This line enables HP-IL chip, Calibration RAM or X RAM for a CPU read operation. | U508 pin 8, Logic Circuitry, Schematic 2. |
| LRST | Low Reset. When this line goes low, the CPU is set to address 3000 Hex. RESET occurs when the front panel switch is turned on, or the rear panel switch is pushed in and then released. | U514 pin 1, Logic Circuitry, Schematic 2. |
| LWRT | Low Write. This line enables HP-IL chip, Calibration RAM or XRAM for a CPU write operation. | U508 pin 10, Logic Circuitry, Schematic 2. |
| SA1 | Signature Analysis. This line is activated by placing the rear panel switch segment 1 in the down position and performing a specified sequence of events (see Service Group E). On early units, this was done with switch segment 4. | S501 segment 1, Schematic 2. On instruments with a 03421-66501 motherboard, this was switch segment 4. |
| SD | Serial Data. Data to display and option cards. | U508 pin 28, Logic and option cards. Circuitry, Schematic 2. |
| VB | Main Battery Voltage (switched). This is the main battery voltage Schematic 3 which is removed from the 3421A when the front panel switch is turned "OFF". | Power Supply, Schematic 3. |
| VBATT | Main Battery Voltage (unswitched). is the main battery voltage that is removed from the instrument only when the rear panel switch is held in. VBATT is not removed when the front panel switch is turned "OFF". | Power Supply, Schematic 3 |
| VCC | +5V (same origin as VDD). | Power Supply, Schematic 3. |
| VDD | +5V (same origin as VCC). | Power Supply, Schematic 3. |
| VSS | Ground. | |

### 1-8-H-5. Block Diagram

1-8-H-6. A detailed block diagram of the HP 3421A is shown in Figure 1-8-H-1. This block diagram shows various HP 3421A test points, and the voltages at those test points where appropriate.

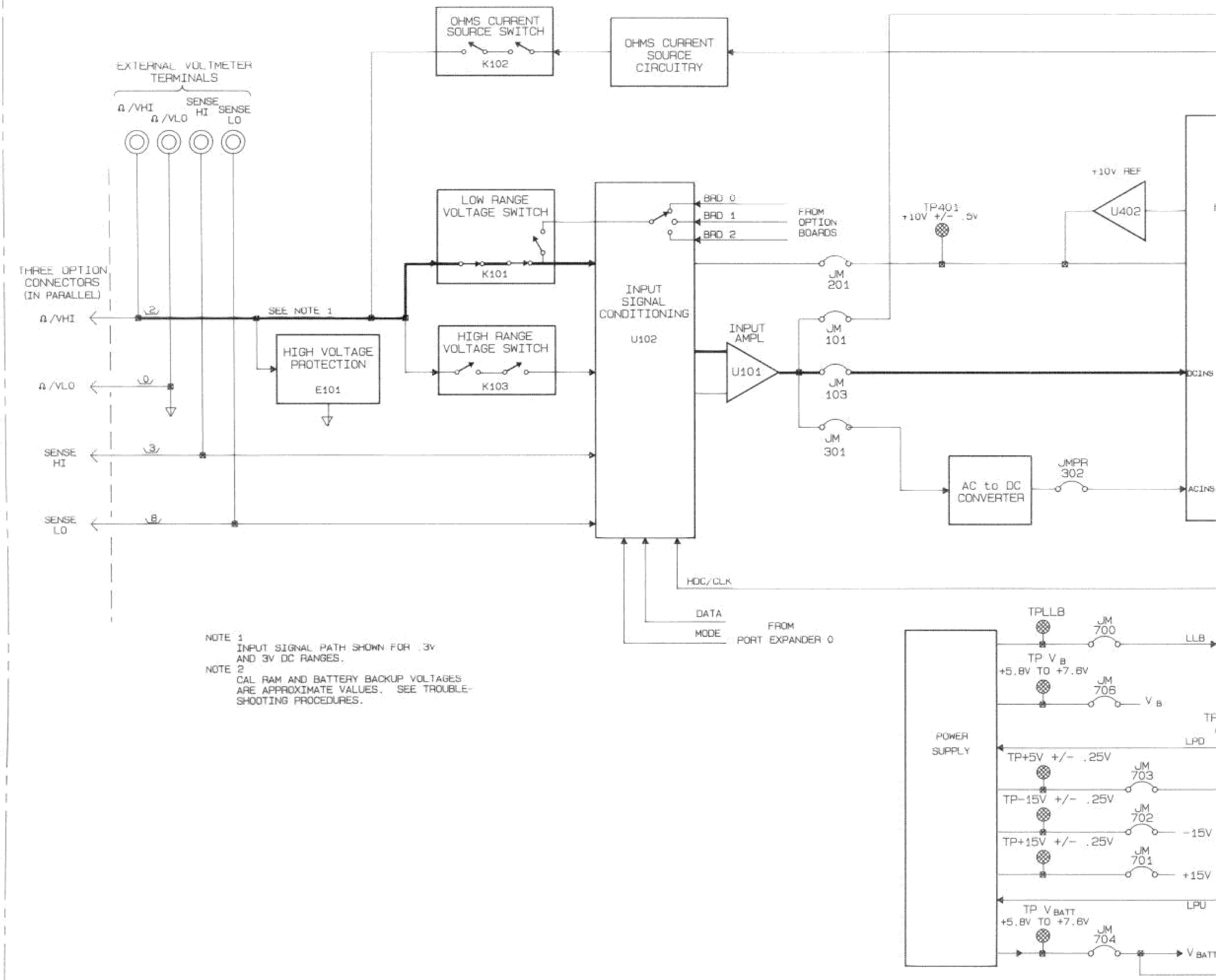
### 1-8-H-7. Component Locator

1-8-H-8. The component locator is located on the apron page of each schematic.

### 1-8-H-9. Schematics

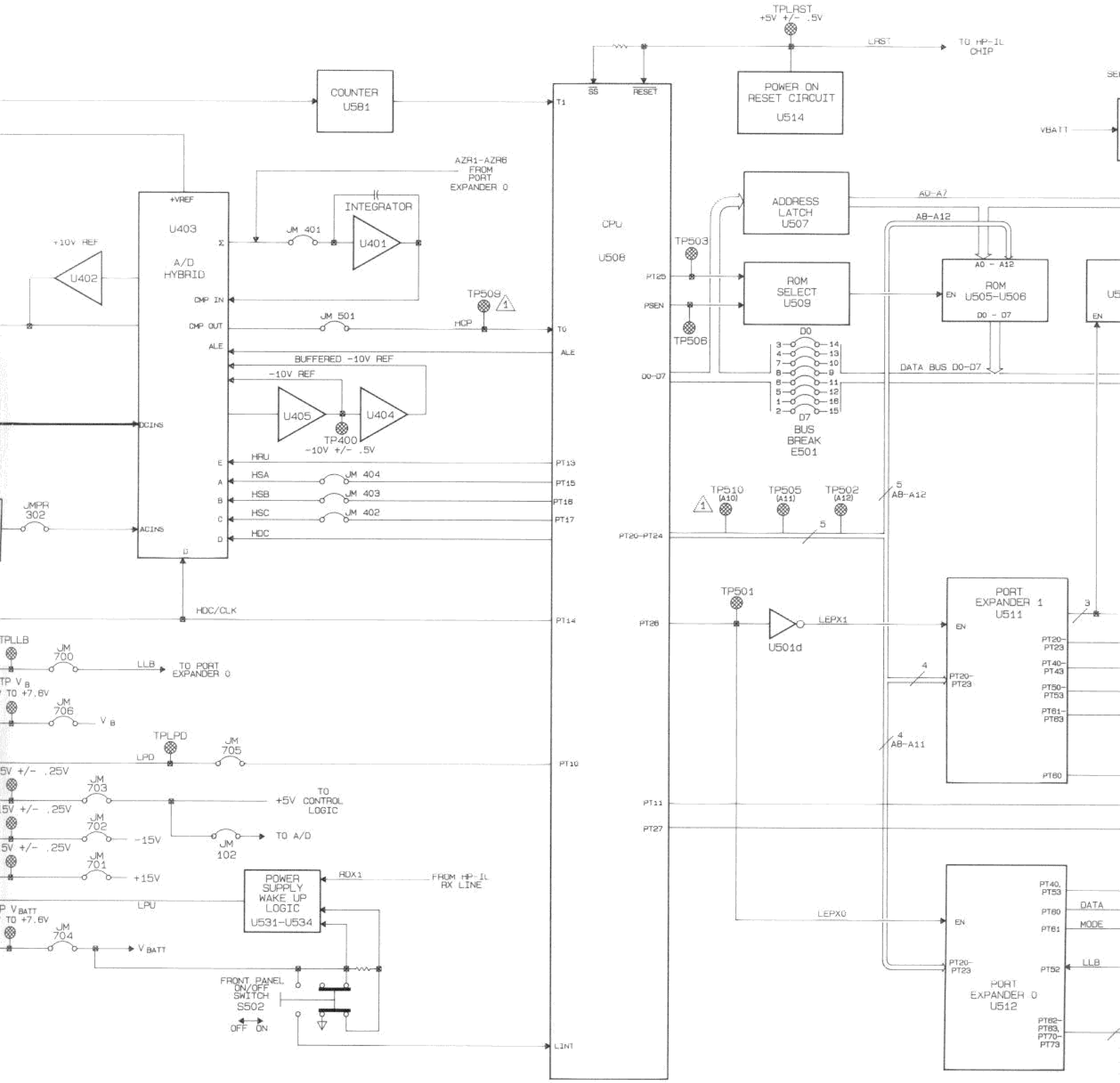
1-8-H-10. There are three schematics for the HP 3421A. The schematics are functionally grouped so they can be easily associated to the block diagram. The three schematics are as follows:

| Figure | Description |
|---|---|
| 1-8-H-2 | Input Circuitry, Ohms Current Source, AC to DC Converter, and A/D Converter. |
| 1-8-H-3 | Control Logic. |
| 1-8-H-4 | Power Supply. |




NOTE 1
INPUT SIGNAL PATH SHOWN FOR .3V AND 3V DC RANGES.

NOTE 2
CAL RAM AND BATTERY BACKUP VOLTAGES ARE APPROXIMATE VALUES. SEE TROUBLESHOOTING PROCEDURES.



TPLRST
+5V +/- .5V
LRST
TO HP-IL CHIP
COUNTER
U581
POWER ON RESET CIRCUIT
U514
VBATT
CPU
U508
AZR1-AZR6 FROM PORT EXPANDER 0
+VREF
U403
A/D HYBRID
INTEGRATOR
JM 401
U401
+10V REF
U402
CMP IN
CMP OUT
JM 501
HCP
TP509
TP503
TP506
ADDRESS LATCH
U507
ROM SELECT
U509
A0-A7
A8-A12
ROM
U505-U506
D0 - D7
DATA BUS D0-D7
BUS BREAK
E501
ALE
BUFFERED -10V REF
-10V REF
U405
U404
TP400
-10V +/- .5V
DCINS
HRU
HSA
HSB
HSC
HDC
JM 404
JM 403
JM 402
JMPR 302
ACINS
TP510 (A10)
TP505 (A11)
TP502 (A12)
PT20-PT24
HDC/CLK
TP501
U501d
LEPX1
PORT EXPANDER 1
U511
TPLLB
JM 700
LLB
TO PORT EXPANDER 0
TP VB
TO +7.6V
JM 706
TPLPD
LPD
JM 705
JM 703
+5V +/- .25V
+5V TO CONTROL LOGIC
JM 702
-15V
JM 102
TO A/D
JM 701
+15V
POWER SUPPLY WAKE UP LOGIC
U531-U534
RDX1
FROM HP-IL RX LINE
LPU
TP VBATT
JM 704
FRONT PANEL ON/OFF SWITCH
S502
OFF ON
LINT
LEPX0
DATA
MODE
PORT EXPANDER 0
U512

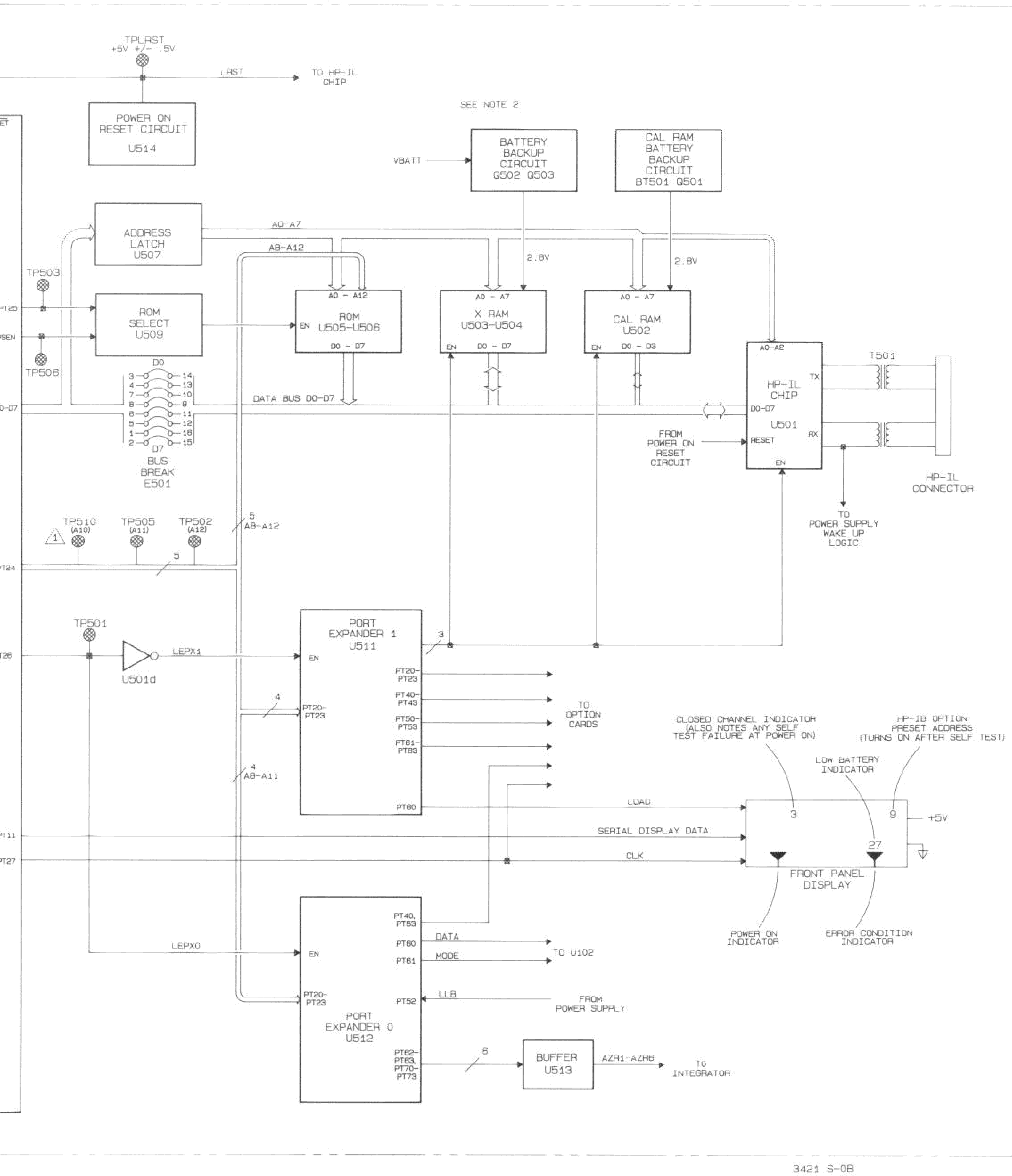
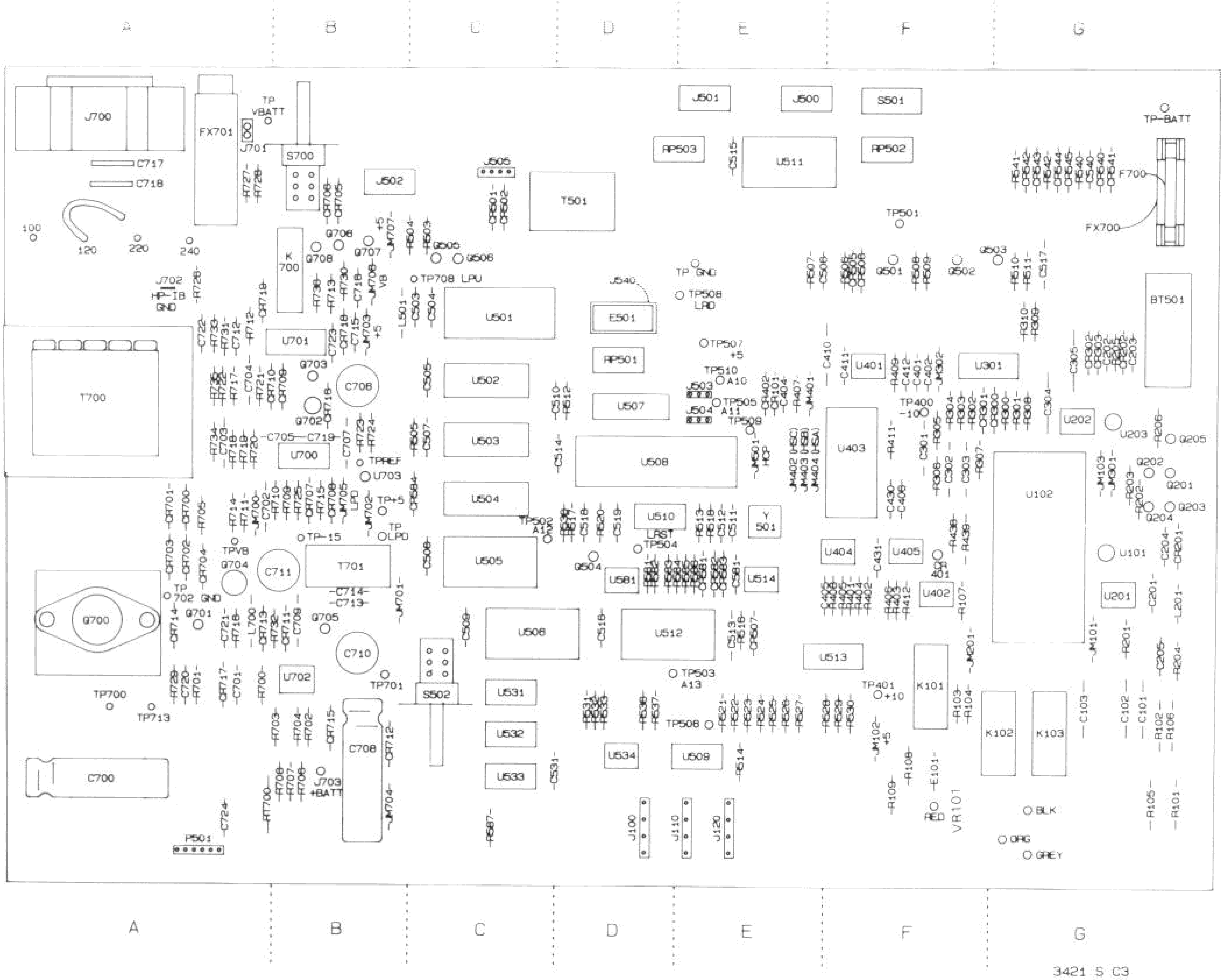



Figure 1-8-H-1. Detailed Block Diagram



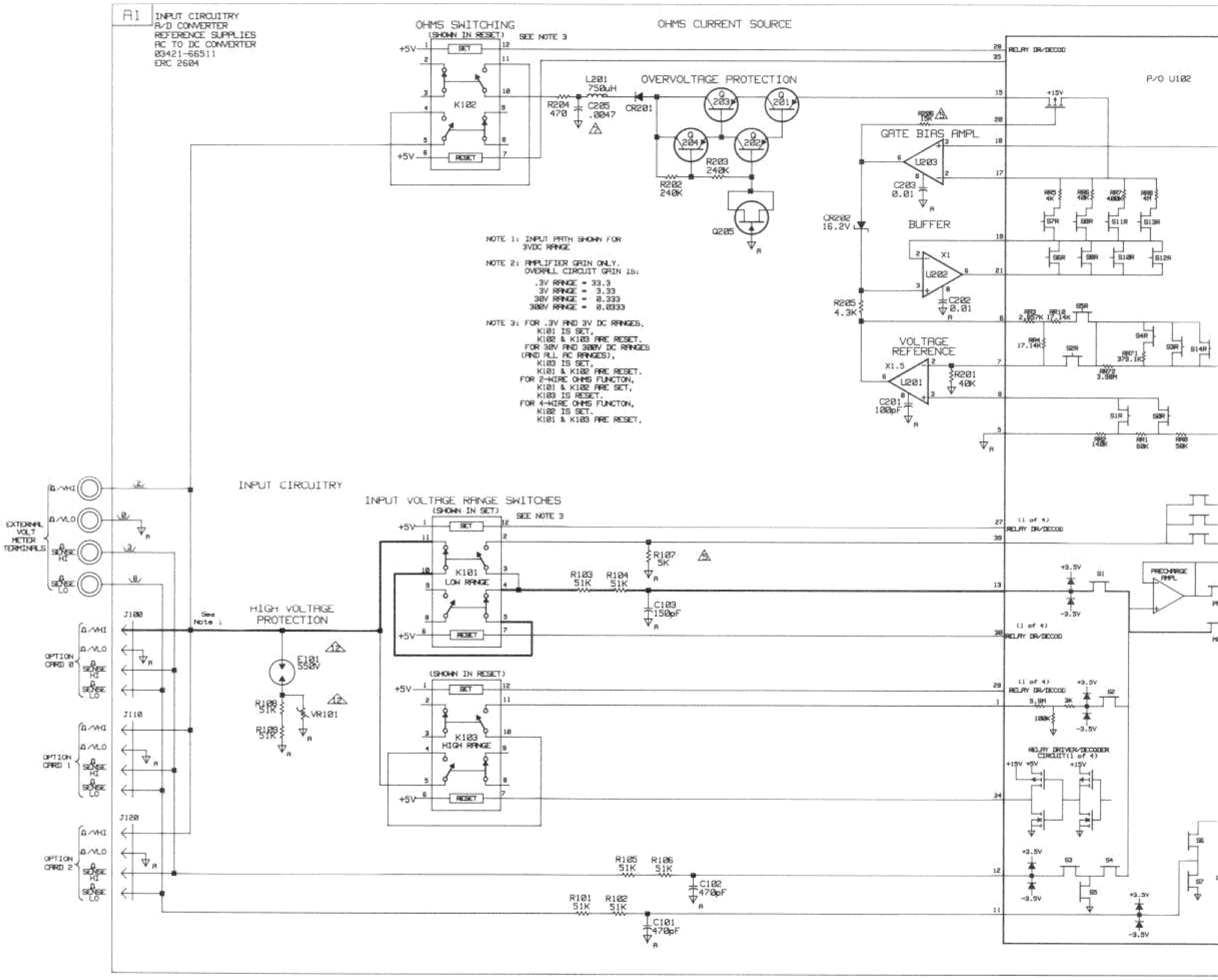
Board Part Number; 03421-66511
ERC: 2604

## IC Power Supply Configurations For Schematic 1

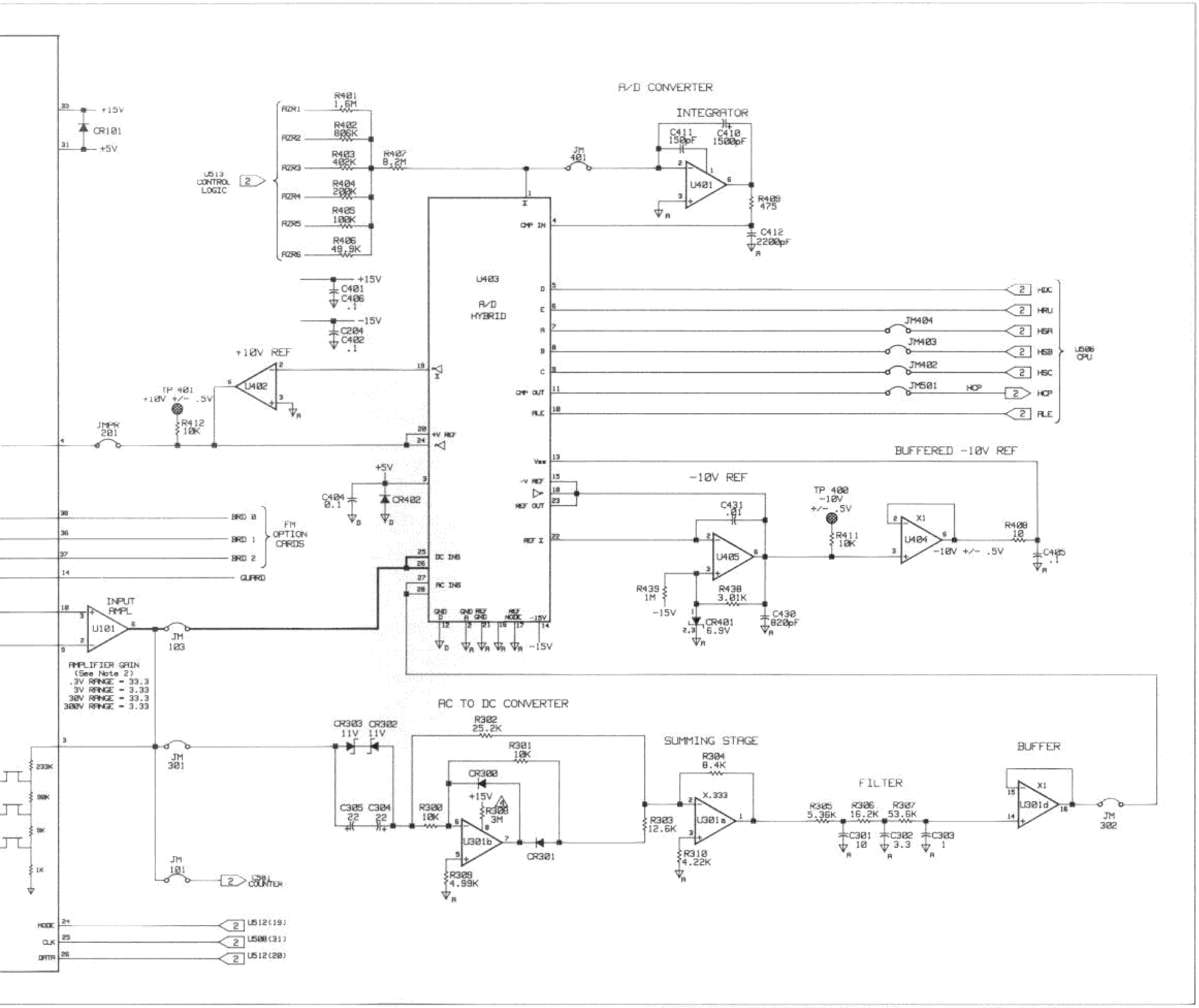
| IC # | Type | -hp- P/N | RAW | +15V | −15V | VB | VBATT | +5V | GND |
|---|---|---|---|---|---|---|---|---|---|
| U101 | AD542KH | 1826-0822+D | 7 | 4 | — | — | — | — | — |
| U102 | Hybrid | 1QH5-0085 | — | 33 | 22 | — | — | 31 | 2,5,23,32,41 |
| U201 | LM308 | 1826-0493 | 7 | 4 | — | — | — | — | — |
| U202 | LM308 | 1826-0493 | 7 | 4 | — | — | — | — | — |
| U203 | LM208 | 1826-0072 | 7 | 4 | — | — | — | — | — |
| U301 | LM346 | 1826-0719 | 4 | 13 | — | — | — | — | — |
| U401 | LM201 | 1826-0059 | 7 | 4 | — | — | — | — | |
| U402 | OP-07CP | 1826-0635 | 7 | 4 | — | — | — | — | — |
| U403 | Hybrid | 1QF6-0066 | — | 14 | — | — | — | 3 | 2,12,16,17,21 |
| U404 | LM741 | 1826-0271 | — | 4 | — | — | — | — | 7 |
| U405 | OP-07CP | 1826-0635 | — | 4 | — | — | — | — | 7 |

## Grid Locator For Schematic 1

| Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column |
|---|---|---|---|---|---|---|---|
| C101 | G | CR301 | F | Q204 | G | R310 | G |
| C102 | G | CR302 | G | Q205 | G | R401 | F |
| C103 | G | CR303 | G | R101 | G | R402 | F |
| | | CR401 | F | R102 | G | R403 | F |
| C201 | G | CR402 | E | R103 | F | R404 | F |
| C202 | G | E101 | F | R104 | F | R405 | F |
| C203 | G | J100 | D | R105 | G | R406 | F |
| C204 | G | J110 | E | R106 | G | R407 | E |
| C205 | G | J120 | E | R107 | F | R408 | F |
| C301 | F | JM101 | G | R108 | F | R409 | F |
| C302 | F | JM102 (+5) | F | R109 | F | R411 | F |
| C303 | F | JM103 | G | R201 | G | R412 | F |
| C304 | G | JM201 | F | R202 | G | R438 | F |
| C305 | G | JM301 | G | R203 | G | R439 | F |
| C401 | F | JM302 | F | R204 | G | TP400 (−10) | F |
| C402 | F | JM401 | E | R205 | G | TP401 | F |
| C404 | E | JM501 (HCP) | E | R206 | G | U101 | G |
| C405 | E-F | JM404 (HSA) | E | R300 | G | U102 | G |
| C406 | F | JM403 (HSB) | E | R301 | G | U201 | G |
| C410 | E-F | JM402 (HSC) | E | R302 | F | U202 | G |
| C411 | F | K101 | F | R303 | F | U203 | G |
| C412 | F | K102 | F-G | R304 | F | U301 | F-G |
| C430 | F | K103 | G | R305 | F | U401 | F |
| C431 | F | L201 | G | R306 | F | U402 | F |
| CR101 | E | Q201 | G | R307 | F | U403 | F |
| CR201 | G | Q202 | G | R308 | G | U404 | F |
| CR202 | G | Q203 | G | R309 | G | U405 | F |
| CR300 | F-G | | | | | VR101 | F |




△ THIS INDICATES A CHANGE FROM THE ORIGINAL DESIGN. THE NUMBER CORRESPONDS TO THE CHANGE NUMBER IN SECTION VII.

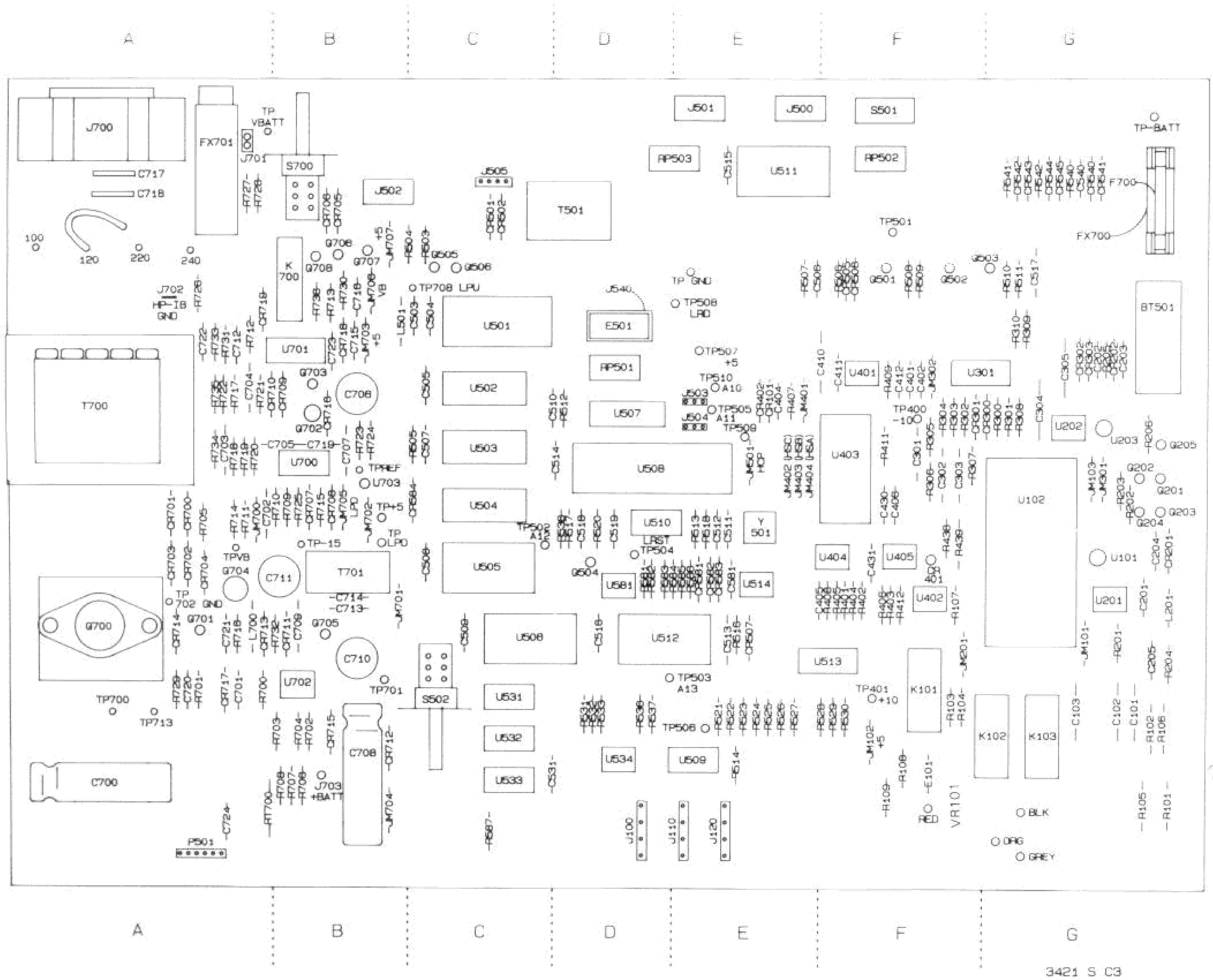





3421 S 1A/1(RE)

1

Figure 1-8-H-2. Input Circuitry, Ohms Current Source, AC to DC Converter, and A/D Converter



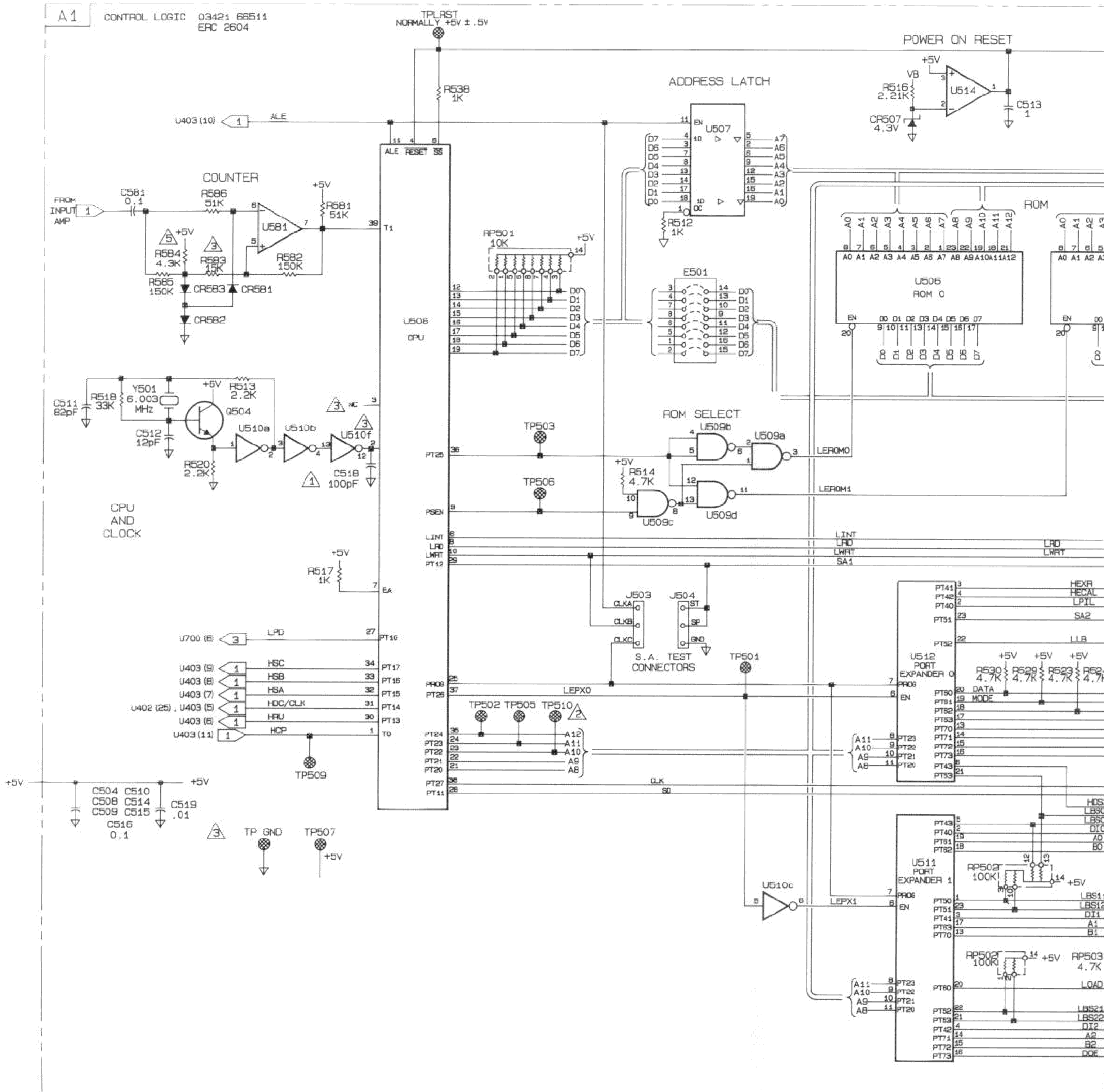
Board Part Number; 03421-66511
ERC: 2604

## IC Power Supply Configurations for Schematic 2

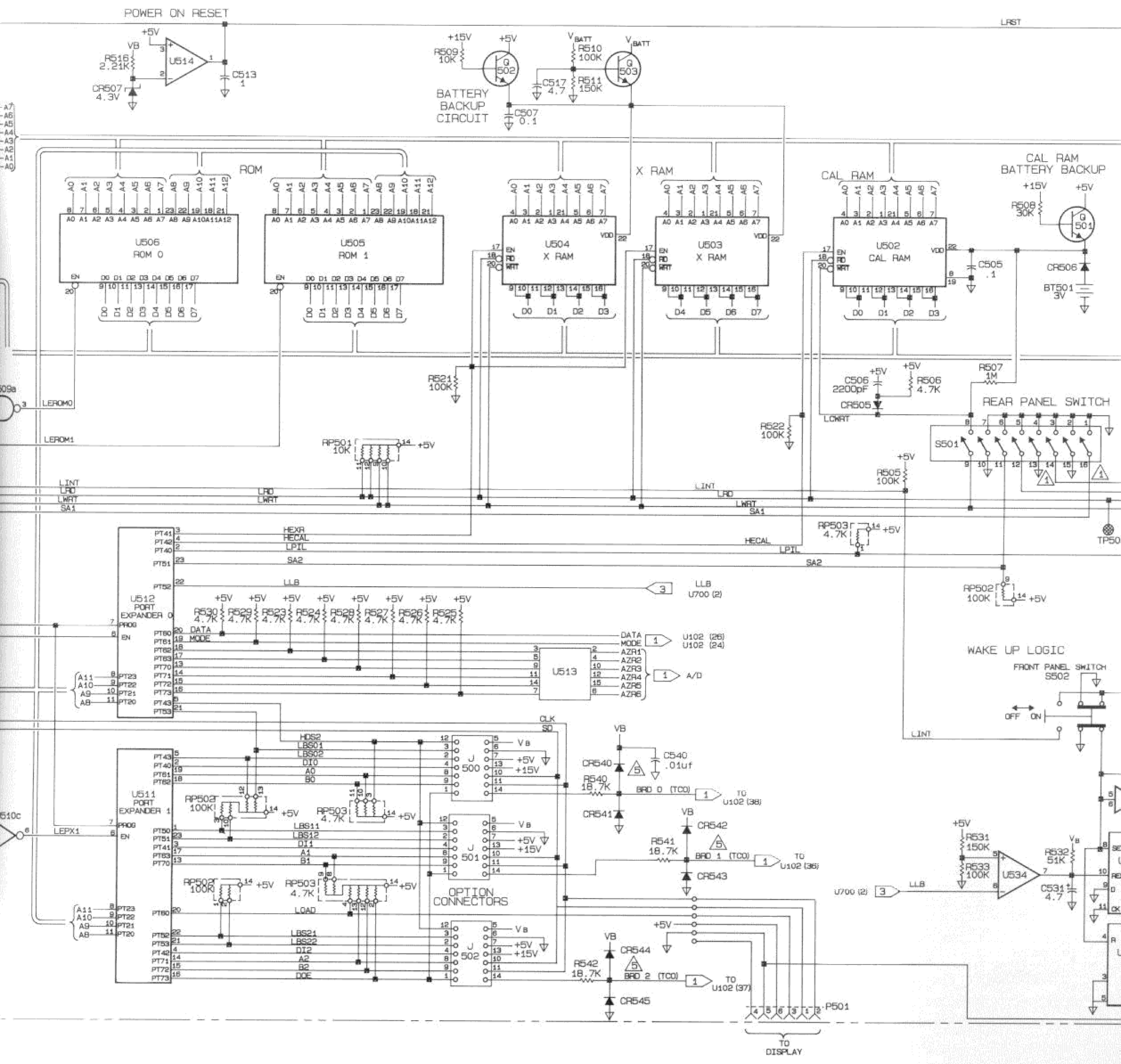
| IC # | Type | -hp- P/N | RAW | +15V | −15V | VB | VBATT | +5V | GND |
|---|---|---|---|---|---|---|---|---|---|
| U501 | HP-IL | 1LB3-0003 | — | — | — | — | — | 1,2,21,22 | 10 |
| U502 | UPD5101 | 1818-1754 | — | — | — | — | — | 22 | 8,19 |
| U503 | UPD5101 | 1818-1754 | — | — | — | — | 22 | 22 | 8,19 |
| U504 | UPD5101 | 1818-1754 | — | — | — | — | 22 | 22 | 8,19 |
| U505 | 64k ROM | 1818-3079 | — | — | — | — | — | 24 | 12 |
| U506 | 64k ROM | 1818-3080 | — | — | — | — | — | 24 | 12 |
| U507 | 74LS373 | 1820-2102 | — | — | — | — | — | 20 | 10 |
| U508 | 8039 CPU | 1820-2718 | — | — | — | — | — | 40,26 | 20 |
| U509 | 74LS00 | 1820-1197 | — | — | — | — | — | 14 | 7 |
| U510 | 74LS04 | 1820-1199 | — | — | — | — | — | 14 | 7 |
| U511 | 8243 | 1820-2177 | — | — | — | — | — | 24 | 12 |
| U512 | 8243 | 1820-2177 | — | — | — | — | — | 24 | 12 |
| U513 | MC14050 | 1820-1146 | — | — | — | — | — | 1 | 8 |
| U514 | LM393 | 1826-0412 | — | 8 | — | — | — | — | 4 |
| U531 | MC14001 | 1820-1745 | — | — | — | — | 14 | — | 7 |
| U532 | MC14081 | 1820-1486 | — | — | — | — | 14 | — | 7 |
| U533 | MC14013 | 1820-0939 | — | — | — | — | 14 | — | 7 |
| U534 | LM393 | 1826-0412 | — | — | — | — | — | 8 | 4 |
| U581 | LM393 | 1826-0412 | — | — | — | — | — | 8 | 4 |

## Grid Locator For Schematic 2 Components

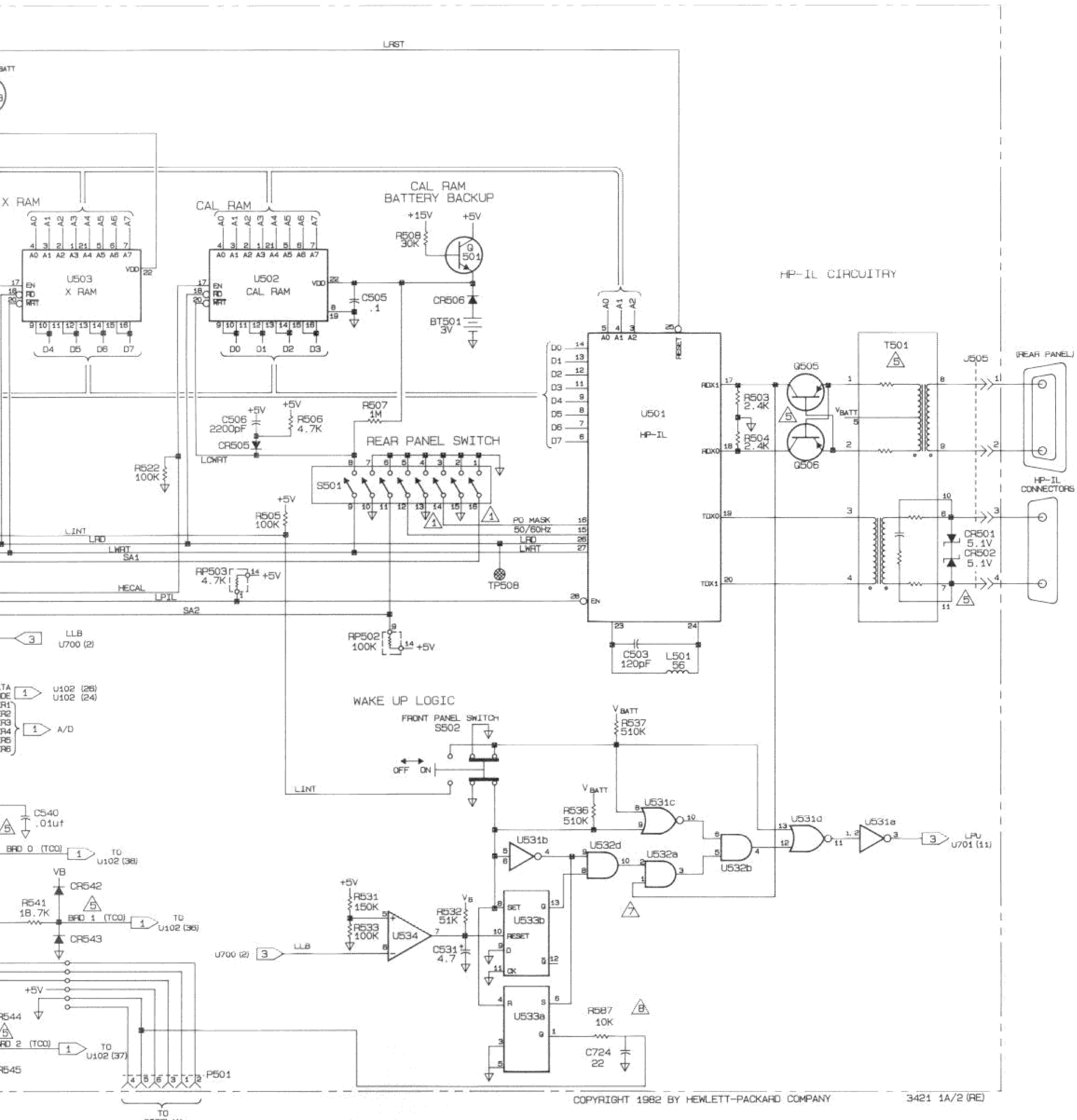
| Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column |
|---|---|---|---|---|---|---|---|
| BT501 | G | CR581 | E | R517 | D | S502 | C |
| C503 | C | CR582 | E | R518 | E | T501 | C-D |
| C504 | C | CR583 | E | R520 | D | TP501 | F |
| C505 | C | CR584 | C | R521 | E | TP502 | C |
| C506 | E | E501 | D | R522 | E | TP503 | D |
| C507 | C | J500 | E | R523 | E | TP504 | D |
| C508 | C | J501 | E | R524 | E | TP505 | E |
| C509 | C | J502 | B | R525 | E | TP506 | E |
| C510 | D | J503 | E | R526 | E | TP507 | E |
| C511 | E | J504 | E | R527 | E | TP508 | D-E |
| C512 | E | J505 | C | R528 | E-F | TP509 | E |
| C513 | E | J540 | D | R529 | F | TP510 | E |
| C514 | D | L501 | B | R530 | F | U501 | C |
| C515 | E | P501 | A | R531 | D | U502 | C |
| C516 | D | Q501 | F | R532 | D | U503 | C |
| C517 | G | Q502 | F | R533 | D | U504 | C |
| C518 | D | Q503 | F | R536 | D | U505 | C |
| C519 | D | Q504 | E | R537 | D | U506 | C |
| C531 | E-D | Q505 | C | R538 | D | U507 | D |
| C540 | G | Q506 | C | R540 | G | U508 | D-E |
| C581 | E | R503 | C | R541 | G | U509 | E |
| C724 | A | R504 | B-C | R542 | G | U510 | E |
| CR501 | C | R505 | C | R581 | D | U511 | E |
| CR502 | G | R506 | F | R582 | D | U512 | D-E |
| CR505 | F | R507 | E | R583 | D | U513 | E-F |
| CR506 | F | R508 | F | R584 | D-E | U514 | E |
| CR507 | E | R509 | F | R585 | E | U531 | C |
| CR540 | G | R510 | G | R586 | E | U532 | C |
| CR541 | G | R511 | G | R587 | C | U533 | C |
| CR542 | G | R512 | D | RP501 | D | U534 | D |
| CR543 | G | R513 | E | RP502 | F | U581 | D |
| CR544 | G | R514 | E | RP503 | D-E | Y501 | E |
| CR545 | G | R516 | E | S501 | F | | |




△ THIS INDICATES A CHANGE FROM THE ORIGINAL DESIGN. THE NUMBER CORRESPONDS TO THE CHANGE NUMBER IN SECTION VII.



POWER ON RESET
BATTERY BACKUP CIRCUIT
ROM
X RAM
CAL RAM
CAL RAM BATTERY BACKUP
REAR PANEL SWITCH
WAKE UP LOGIC
FRONT PANEL SWITCH S502
U506 ROM 0
U505 ROM 1
U504 X RAM
U503 X RAM
U502 CAL RAM
U512 PORT EXPANDER 0
U511 PORT EXPANDER 1
U513
U514
U534
OPTION CONNECTORS
TO DISPLAY




**2**

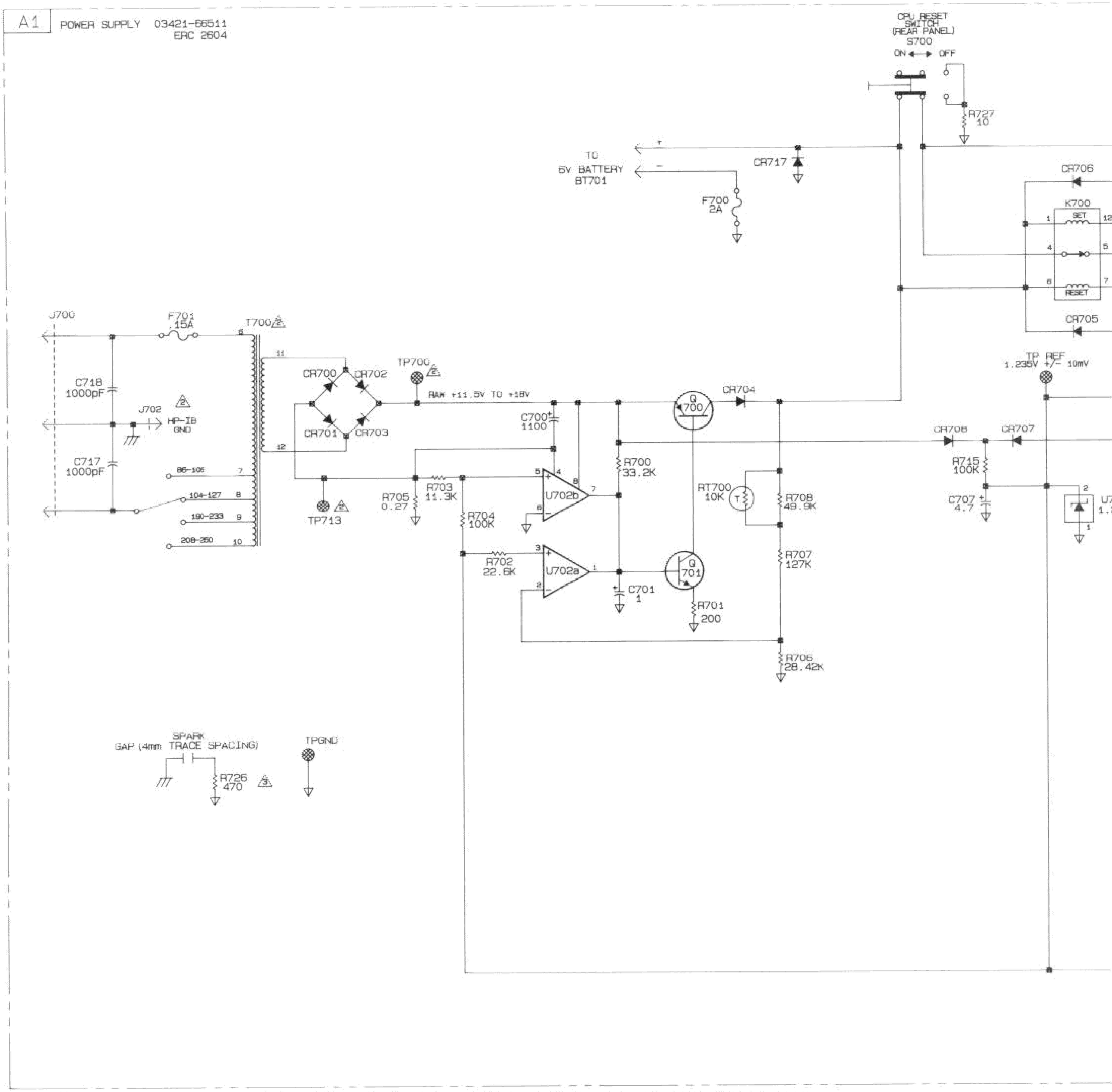
Figure 1-8-H-3. Control Logic

## IC Power Supply Configurations for Schematic 3

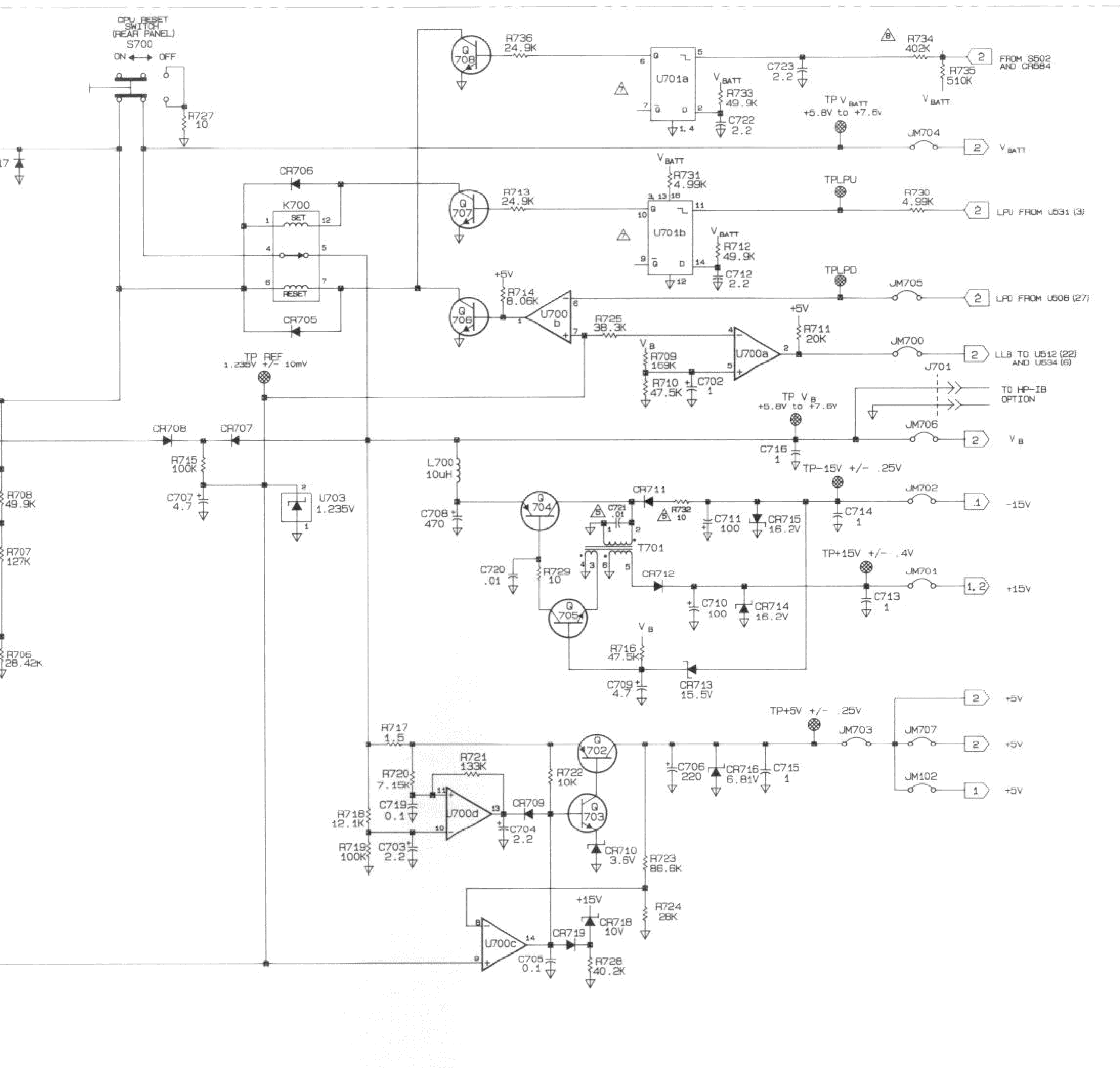
| IC # | Type | -hp- P/N | RAW | +15V | -15V | VB | VBATT | +5V | GND |
|---|---|---|---|---|---|---|---|---|---|
| U700 | MC3302 | 1826-0174 | – | 3 | – | – | – | – | 12 |
| U701 | MC14538 | 1820-1932 | – | – | – | – | 3,13,16 | – | 1,4,5,8,12,15 |
| U702 | LM393 | 1826-0412 | 8 | – | – | – | – | – | 4 |

## Grid Locator For Schematic 3 Components

| Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column | Reference Designator | Grid Column |
|---|---|---|---|---|---|---|---|
| C700 | A | CR708 | B | Q703 | B | R725 | B |
| C701 | A | CR709 | B | Q704 | A | R726 | A |
| C702 | A | CR710 | A-B | Q705 | B | R727 | A |
| C703 | A | CR711 | B | Q706 | B | R728 | A |
| C704 | A | CR712 | B | Q707 | B | R729 | A |
| C705 | B | CR713 | A-B | Q708 | B | R730 | B |
| C706 | B | CR714 | A | R700 | A | R731 | A |
| C707 | B | CR715 | B | R701 | A | R732 | B |
| C708 | B | CR716 | B | R702 | B | R733 | A |
| C709 | B | CR717 | A | R703 | B | R734 | A |
| C710 | B | CR718 | B | R704 | B | R735 | A |
| C711 | A-B | CR719 | A | R705 | A | R736 | B |
| C712 | A | F700 | G | R706 | B | RT700 | A-B |
| C713 | B | FX700 | G | R707 | B | S700 | B |
| C714 | B | FX701 | A | R708 | B | T700 | A |
| C715 | B | J700 | A | R709 | B | T701 | B |
| C716 | B | J701 | A | R710 | B | TP+5V | B |
| C717 | A | J702 | A | R711 | A | TP+15V | B |
| C718 | A | JM102 | F | R712 | A | TP−15V | B |
| C719 | B | JM700 (LLB) | A | R713 | B | TPBATT | G |
| C720 | A | JM701 (+15) | B | R714 | A | TPLPD | B |
| C721 | A | JM702 (−15) | B | R715 | B | TPLPU | B |
| C722 | A | JM703 (+5) | B | R716 | A | TPREF | B |
| C723 | B | JM704(VBATT) | B | R717 | A | TPVB | A |
| CR700 | A | JM705 (LPD) | B | R718 | A | TPVBATT | A |
| CR701 | A | JM706 (VB) | B | R719 | A | TP700 | A |
| CR702 | A | JM707 | B | R720 | A | TP713 | A |
| CR703 | A | K700 | B | R721 | A | U700 | B |
| CR704 | A | L700 | A | R722 | A | U701 | B |
| CR705 | B | Q700 | A | R723 | B | U702 | B |
| CR706 | B | Q701 | A | R724 | B | U703 | B |
| CR707 | B | Q702 | B | | | | |




△ THIS INDICATES A CHANGE FROM THE ORIGINAL DESIGN THE NUMBER CORRESPONDS TO THE CHANGE NUMBER IN SECTION VII.




VII.





3

Figure 1-8-H-4. Power Supply

# CHAPTER 2
# MODEL 44462A
# (OPTIONS 020, 021, AND 022)
# MULTIPLEXER/ACTUATOR ASSEMBLY

# CHAPTER 2

# MODEL 44462A (OPTIONS 020, 021, AND 022) MULTIPLEXER/ACTUATOR ASSEMBLY

### Engineering Revision Codes (ERCs)

This chapter applies directly to Multiplexer/Actuator Assemblies with an engineering revision code of 2421. See Section VII of this chapter if your assembly has an ERC lower than 2421. If the ERC of your assembly is above 2421, updating information may be on a yellow *MANUAL CHANGES* supplement(located at the front of the manual).

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

2-3-7. When operating with HP-IL, most commands will "hold-up" the computer until all readings have been taken. For example, suppose you have three Multiplexer/Actuator Assemblies installed and you program the instrument to take 30 readings (one reading from each channel). With a reading rate of about two per second, 15 seconds are required to take all 30 readings. The computer can not perform any task while the instrument is making the measurements.

2-3-8. With the HP-IB Option installed, a switch on the option enables and disables buffered transfers. This switch is factory reset to disable buffered transfers (switch up). In the up position, the HP-IB interface acts similar to the HP-IL interface, holding up the computer until all measurements are made. With the switch in the down position, buffered transfers are enabled. This releases the computer while the instrument is making measurements. However, if the computer attempts a subsequent communication operation on the HP-IB interface with the HP 3421A present, the transfer will be held until the measurement function is complete. The buffered transfer mode provides the fastest transfer of information.

### 2-3-9. Commands

2-3-10. Commands sent to the instrument instruct it to perform some specified task. At the end of this section is a list of commands that are used with the Multiplexer/Actuator Assembly. Commands fall into two categories: standard and advanced.

a. Standard commands set up the instrument and then complete a measurement task. For example, the command DCV2,7-9 causes the instrument to take DC Voltage measurements on channels 2, 7, 8, and 9, and store the readings in its internal memory. One command causes a complete measurement task to be performed.

b. Advanced Commands provide additional flexibility, but they do not perform a complete measurement task. These commands perform only one aspect of a measurement. Advanced commands are suitable for those who wish to tailor their system for some particular requirement.

### 2-3-11. Channel List Rules

2-3-12. The channel list specifies the order in which channels will be measured. The series of channels specified must follow these rules.

a. The default channel list (asserted at power on or reset) consists of all multiplexer channels in numerical sequence. The channel list can be loaded with multiplexer channels by the DCV, ACV, TWO, FWO, TEM, FRQ, LS or LP commands. It can also be loaded with digital input bit numbers by the BIT command.

b. Channel addresses are separated by commas. However, a dash may be used to signify a contiguous set of channels. When using Advanced Commands, any command that specifies a channel must be separated from subsequent commands by either a colon (:) or a semicolon (;) but not a comma (,). Example: F1RA1Z1N5LS5-9;T3. If the last character in the command string is a comma, an error will be generated.

c. No more than 30 channels are accepted into the channel list. Legal channel numbers are 00 through 29.

## LIST OF ILLUSTRATIONS

# SECTION I
# GENERAL INFORMATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 2-1-1. INTRODUCTION

2-1-2. This chapter is intended for use by qualified service trained personnel only. Other individuals refer to the ''HP 3421A Operating, Programming, and Configuration Manual''.

2-1-3. The installation and service information of the Multiplexer/Actuator Assembly is in this chapter. The chapter has eight sections that are assigned as follows:

**Section I - General Information**
This section describes the content of Chapter 2, has a brief description of the Multiplexer/Actuator Assembly and lists its specifications.

**Section II - Installation**
This section explains how to connect, install, remove, and configure the Multiplexer/Actuator Assembly. There is also a procedure for cleaning the circuit board and terminal block edge connector.

**Section III - Operation**
This section contains condensed operating instructions for service trained individuals.

**Section IV - Performance Verification and Calibration**
This section contains performance verification procedures for the Multiplexer/Actuator Assembly.

**Section V - Adjustments**
This section normally has the adjustment procedures. However, since the Multiplexer/Actuator Assembly has no adjustments, no procedures will be in this section.

**Section VI - Replaceable Parts**
For ease in obtaining part numbers, all the replaceable parts for the Multiplexer/Actuator Assembly are in Chapter 1 (Mainframe Service Information), Section VI of the manual. Ordering information, and all chassis and mechanical parts are also included.

**Section VII - Manual Changes**
This section contains information to update this chapter for use with Multiplexer/Actuator Assemblies that have ERC numbers different than shown on the title page of this chapter. It also adapts this chapter to assemblies that are different than what is described in this chapter.

**Section VIII - Service**
This section contains troubleshooting information, theory of operation, and the schematic.

## 2-1-4. OPTION DESCRIPTION

2-1-5. The Multiplexer/Actuator Assembly provides ten channels for inputting measurements. It also has a temperature reference junction for thermocouple compensations. Built-in software compensation for T-type thermocouples is provided by the mainframe firmware. Two of the option's ten channels can be configured as actuators for controlling motors, alarms, etc. Channel 2 also has a built-in 10:1 voltage divider or attenuator that is normally bypassed, but can be selected by jumpers.

## 2-1-6. PRINTED CIRCUIT BOARD IDENTIFICATION

2-1-7. The Multiplexer/Actuator Board is identified by the board number and the engineering revision code. These two numbers identify the electrical characteristics of the circuit board. The engineering revision code and board part number are listed on the schematic, component locator, and replaceable parts list.

2-1-8. In any service related correspondence, identify the printed circuit board by using the board number followed by the engineering revision code. For example:

44462-66514-2421

would identify a Multiplexer option circuit board having an engineering revision code of 2421.

## 2-1-9. BOARD PART NUMBER AND ERC NUMBERS

2-1-10. The HP part number of the printed circuit board is etched on the pc board. It is a ten digit number, separated by a hyphen into two groups of five digits. The first five digits identify the model or assembly number; the last five digits are unique to the assembly.

2-1-11. The ERC number is on a label which is the only one on the pc board that has a four digit number. This four digit code is in the form of YYWW, where YY is the last two digits of the year minus 60, and WW is the week. For example, an ERC of 2310 would identify a change that was made to the assembly in the tenth week of 1983. Refer to Chapter 1, Section I for more information on ERC numbers.

## 2-1-12. SPECIFICATIONS

2-1-13. The Multiplexer/Actuator Assembly specifications are listed in Table 2-1-1. These specifications are the performance standards or limits to which the assembly can be tested.

## Table 2-1-1. Multiplexer/Actuator Assembly Specifications

**OPTION 020, 021, and 022 – MULTIPLEXER/ACTUATOR ASSEMBLY**

**Voltage (Scan):**

±300 V peak Hi-earth, Hi-Lo, any two terminals
±150 V peak Lo-earth
250 Vac

**Voltage (Actuate):**

30 Vdc
250 Vac
2 A Maximum
150 VA Maximum

**Contact Resistance (Actuate):**

$<1.4\Omega$

**Thermal Offset (Scan):**

$<3\mu V$

**Average Switch Life:**

$5 \times 10^6$ operations with proper contact protection

**Maximum Switching Rate:**

50/sec.

**Open Contact Capacitance:**

<15 pF

**Closed Channel Capacitance:**

<90 pF with 1 Option 020, 021, or 022
<130 pF with 2 Option 020, 021, or 022
<170 pF with 3 Option 020, 021, or 022

**Interchannel Capacitance:**

<30 pF

| Isolation Resistance | 0-40°C @ RH <65% | 0-40°C @ 65% < RH < 95% |
|---|---|---|
| HI to LO | $\geq 10^{11}$ | $\geq 10^{9}$ |
| HI to EARTH | $\geq 10^{11}$ | $\geq 10^{9}$ |
| LO to EARTH | $\geq 10^{11}$ | $\geq 10^{9}$ |

**Frequency Response**

3 dB point, 50Ω source >1 MHz
3 dB point, 1 MΩ source >1 kHz

All relay scans break before make. Relay configuration at shipment:

| Option | Actuator Channels | Multiplexer Channels | Attenutor on Channel 2 |
|---|---|---|---|
| 020 | 0,1 | 2-9 | Disabled |
| 021 | 0 | 1-9 | Disabled |
| 022 | --- | 0-9 | Disabled |

**REFERENCE JUNCTION COMPENSATION**

| Operating Temperature 23°±5°C | Accuracy |
|---|---|
| Static Environment (±1°C deviations) | ±1°C |
| Dynamic Environment (5°C step or 5°C/hour maximum rate of change) | ±3°C |

**Temperature coefficient for 0-18°C/28-50°C operating ranges**

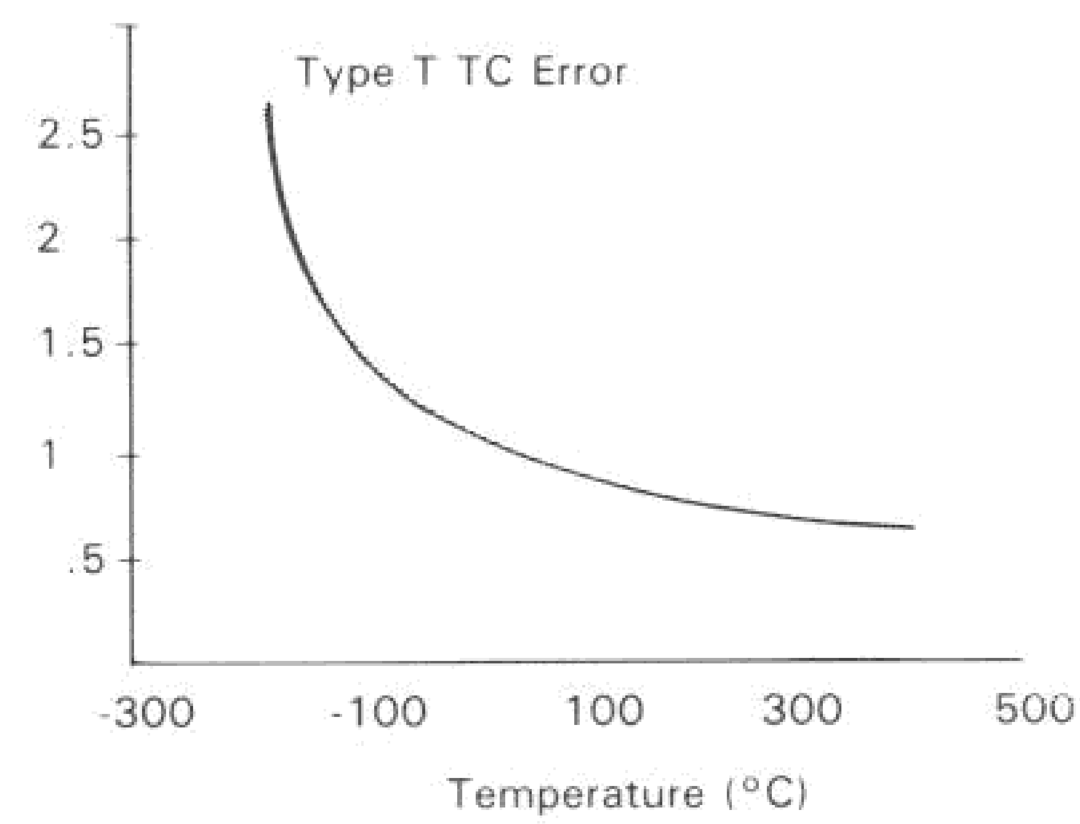
**Add to measurement accuracy:**

.05° for each °C outside of 23°C±5°C

**TYPE T THERMOCOUPLE COMPENSATION**

**Range:** –200°C to +400°C

**Accuracy:** includes reference junction error, thermal offset, dvm error and curve fit. It does not include wire errors.




**Temperature Coefficient:**

.05°C/°C (0–18°C, 28–55°C)

**10:1 ATTENUATOR ON CHANNEL 2 (44469A ASSEMBLY)**

$Z_{in}$ : 1 MΩ ±1%

$C_{in}$ : ≤25 pF

Add 1% reading error when using attenuator

**Maximum Input Voltage for Attenuator**

300 V peak

# SECTION II
# INSTALLATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 2-2-1. INTRODUCTION

2-2-2. This section explains how to remove, configure, and install the Multiplexer/Actuator Assembly, and how to wire the terminal block edge connector. At the end of this section there is a procedure for cleaning the Multiplexer/Actuator circuit board and the terminal block edge connector.

2-2-3. Always use clean handling techniques and anti-static procedures when removing, configuring, and installing this assembly. If measurements are to made under high humidity (>80%) and/or high temperatures (>32°C or >90°F), the circuit board and the terminal block edge connector should be cleaned. Also clean the terminal block edge connector if very high resistance measurements or voltage measurements in high impedance circuits are to be made. See paragraph 2-2-48.

## 2-2-4. INITIAL INSPECTION

2-2-5. This option was carefully inspected and tested at the factory. If this option was ordered separately and needs to be installed in the HP 3421A, visually inspect it for physical damage that may have occured during transit. If there is any damage, promptly notify the nearest Hewlett-Packard Sales and Service Office. A listing of these offices is located at the end of this manual. If the shipping carton is damaged or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard Office, and keep the shipping materials for the carrier's inspection. The sales and service office will arrange for repair or replacement of your assembly (at HP's option) without waiting for the claim against the carrier to be settled.

## 2-2-6. GENERAL REMOVAL/INSTALLATION PROCEDURES

2-2-7. The following instructions shows how to remove and install the Multiplexer/Actuator Assembly into the HP 3421A. The option assembly should be removed from the Model 3421A mainframe before attempting to reconfigure it.

### 2-2-8. Option Removal Procedure

2-2-9. The following procedure first shows how to remove the instrument's top cover, and then how to remove the options in slots 1, 0, and 2. The top cover has to be removed first before any options can be removed. Also keep in mind that if you wish to remove the option in slot 0, remove the option in slot 1 first. Do the following:

**CAUTION**

*When removing Multiplexer Assemblies, make sure they are re-installed in the slots from which they were removed. If this is not done, the instrument must be re-calibrated for each Multiplexer whose slot location is different than the slot in which it was calibrated.*

**2-2-10. HP 3421A Top Cover Removal Procedure.** Do the following:

a. Make sure the ac power cord is disconnected from the instrument. Also make sure all external sources of power have been removed from the option terminal blocks.

b. Dependent on which options are to be removed, remove the appropriate strain relief and safety cover as follows:

1. Refer to Figure 2-2-1 and remove the two screws holding the black strain relief bar.

2. Loosen the two captive screws that hold the grey "WARNING" safety cover.

3. Loosen the two screws holding the terminal block to the option circuit board and then remove the terminal block.

c. Turn the instrument upside down. This is preferably done on top of a protective mat to reduce the possibility of scratching or marring the instrument case. Refer to Figure 2-2-2 and loosen the six screws on the instrument bottom.

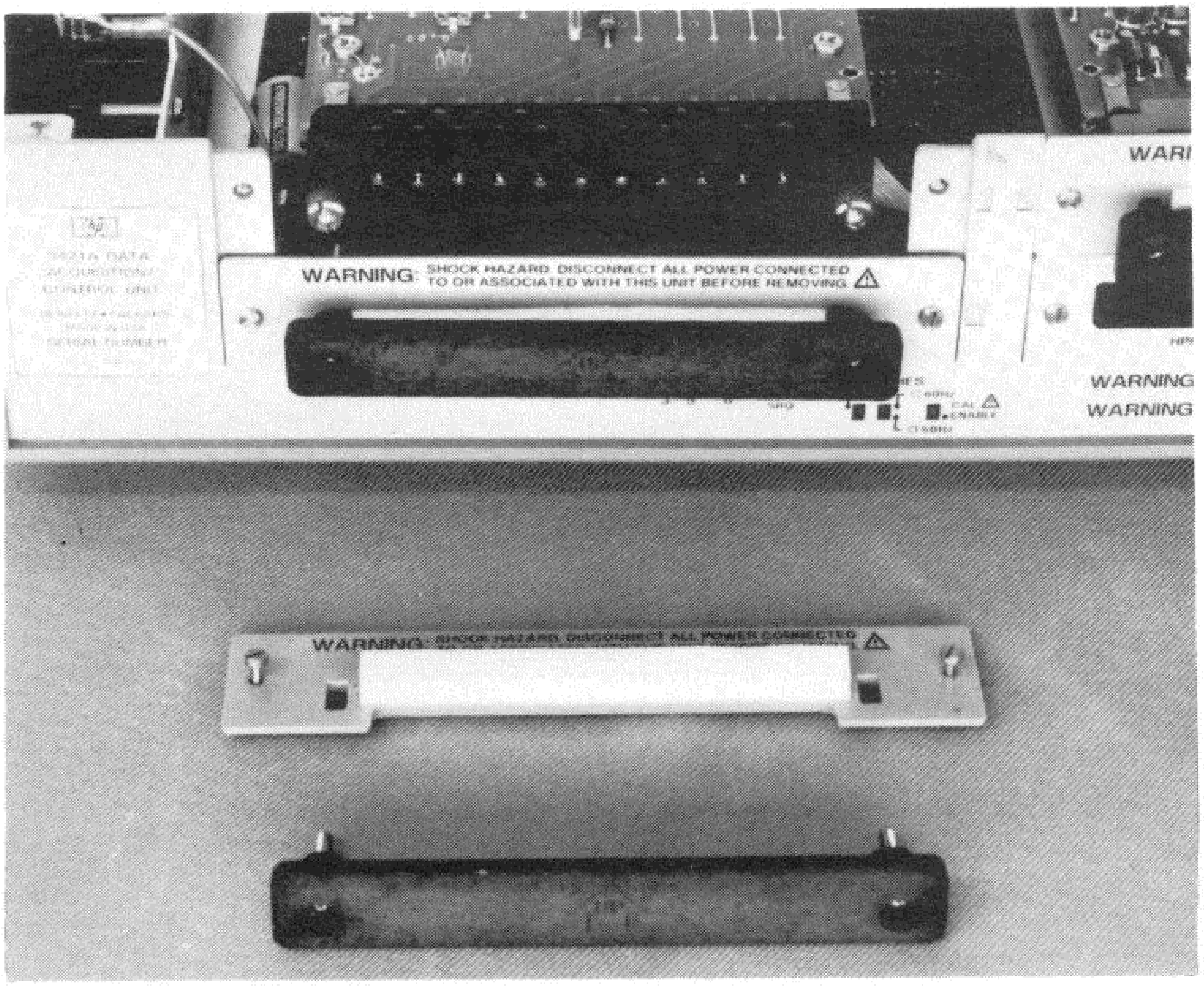



Figure 2-2-1. Remove Strain Relief and Safety Cover

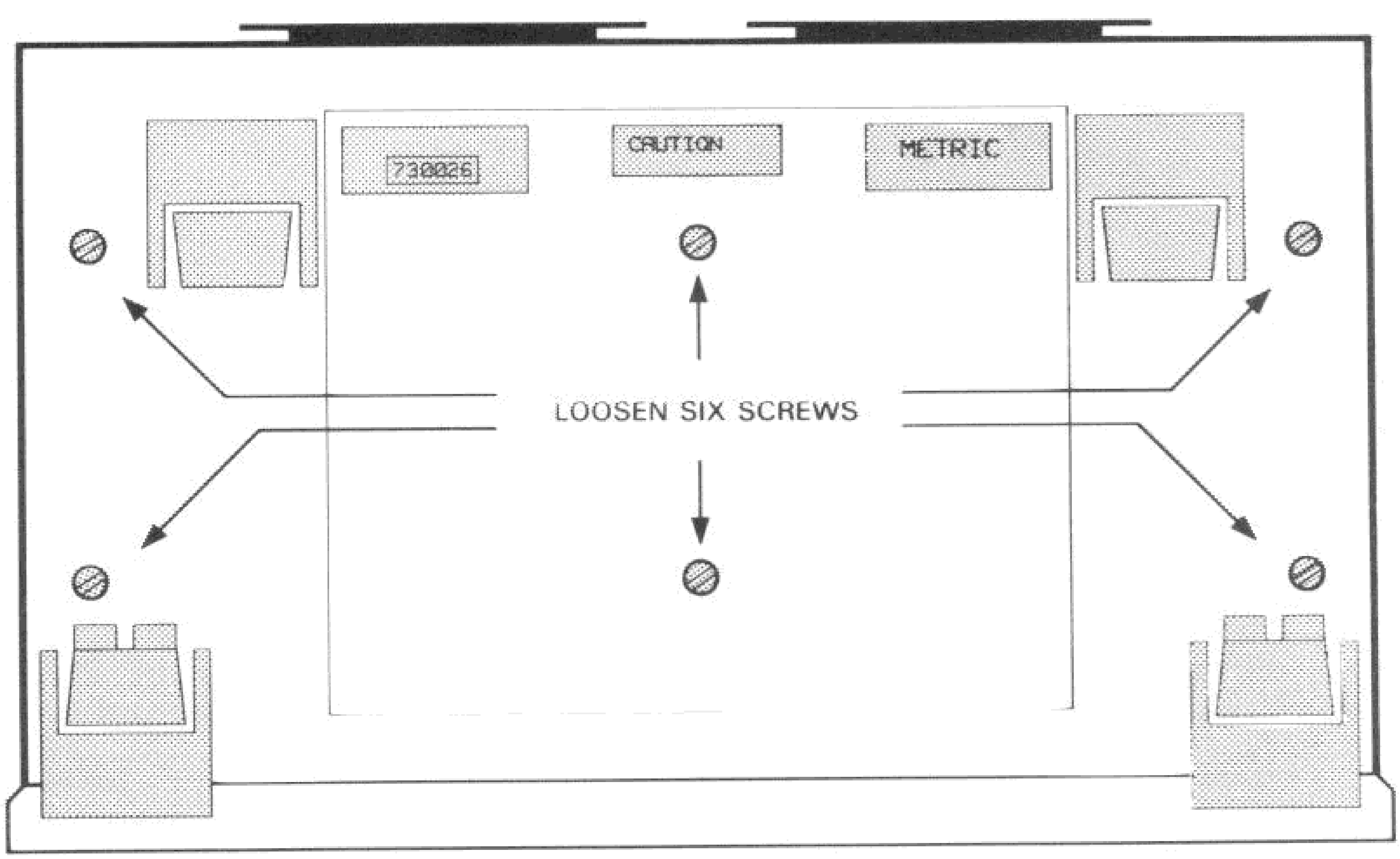



Figure 2-2-2. Loosen Bottom Screws

d. Hold the top cover in place and turn the instrument upright. Then remove the top cover.

e. Refer to Figure 2-2-3 and locate the battery fuse toward the right rear of the instrument. Remove it from its socket. Instead of removing the fuse, you can unplug the red wire from the battery. If this is done, make sure the wire is placed out of the way and away from the battery.

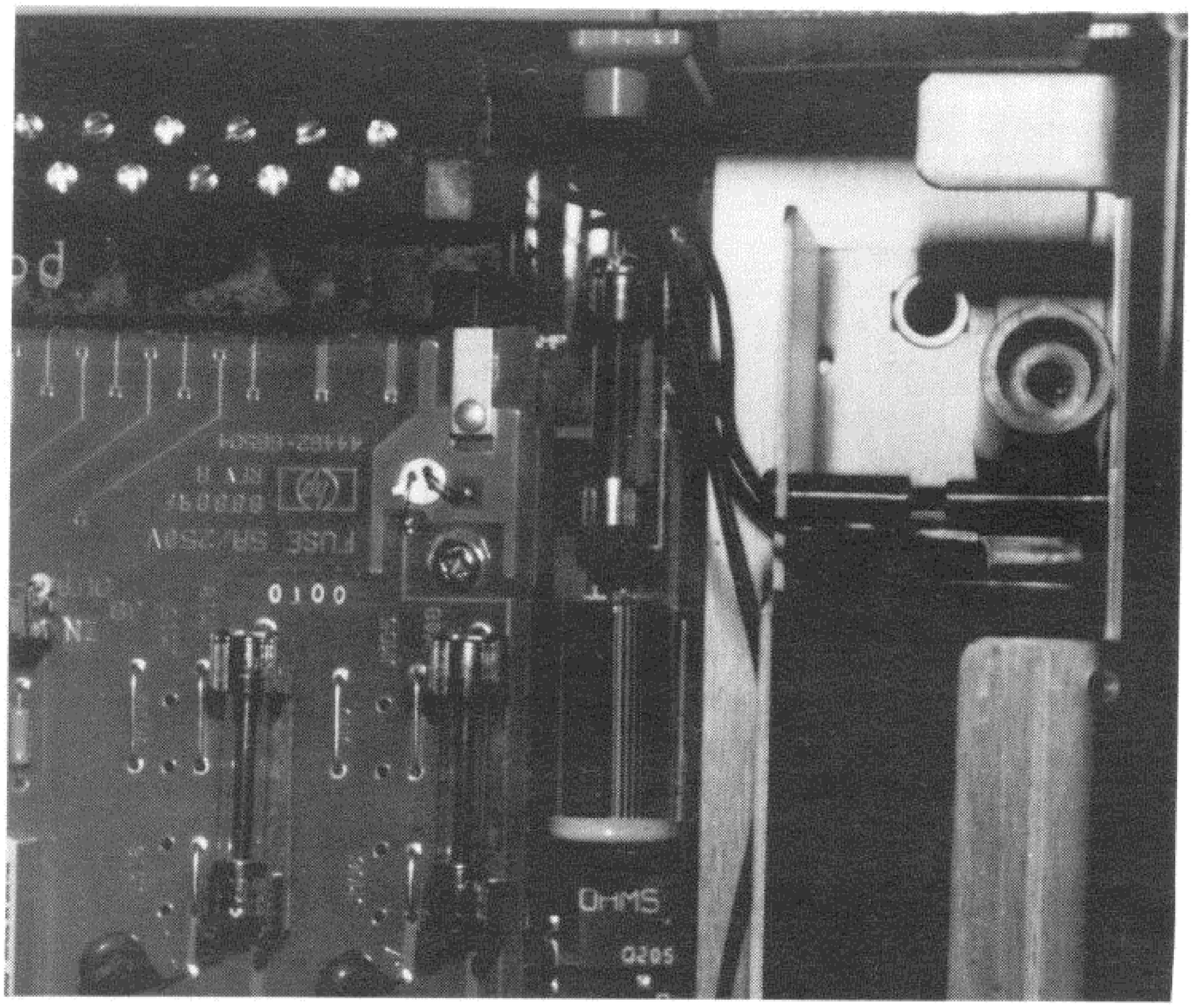


**Figure 2-2-3. Remove Main Battery Fuse**

**2-2-11. Slot 1 Option Removal Procedure.** Do the following:

a. Refer to Figure 2-2-4 and unplug the ribbon cable connector from the option in slot 1. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

b. Locate and remove the four screws holding the option in place.

c. Remove the option from slot 1. To prevent any recalibration of the option, tag the option as option 1 and make sure the same option board is placed back into the instrument into the same slot.

**2-2-12. Slot 0 Option Removal Procedure.** Make sure the option in slot 1 is removed, before removing the option in slot 0. Do the following:

a. Refer to Figure 2-2-4 and unplug the ribbon cable connector from the option in slot 0. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

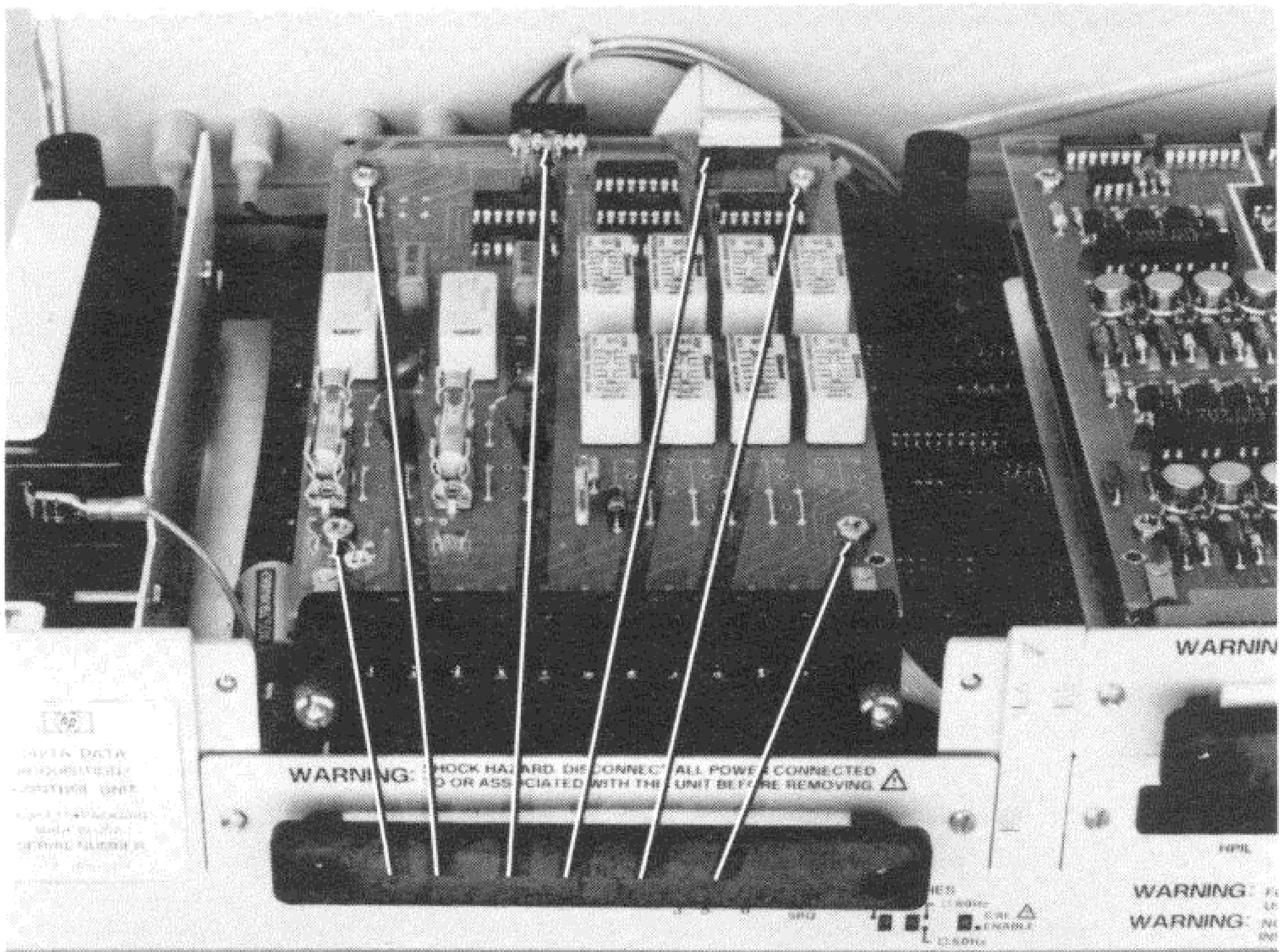



**Figure 2-2-4. Unplug Option Cable(s) and Remove Option Screws**

b. Using a 7/32'' wrench, remove the four hex screws standoffs as shown in Figure 2-2-5.

c. Remove the option from slot 0. To prevent any recalibration of the option, tag the option as option 0 and make sure the same option board is placed back into the instrument into the same slot.

d. Leave the bottom hex standoffs in place to secure the motherboard to the chassis.

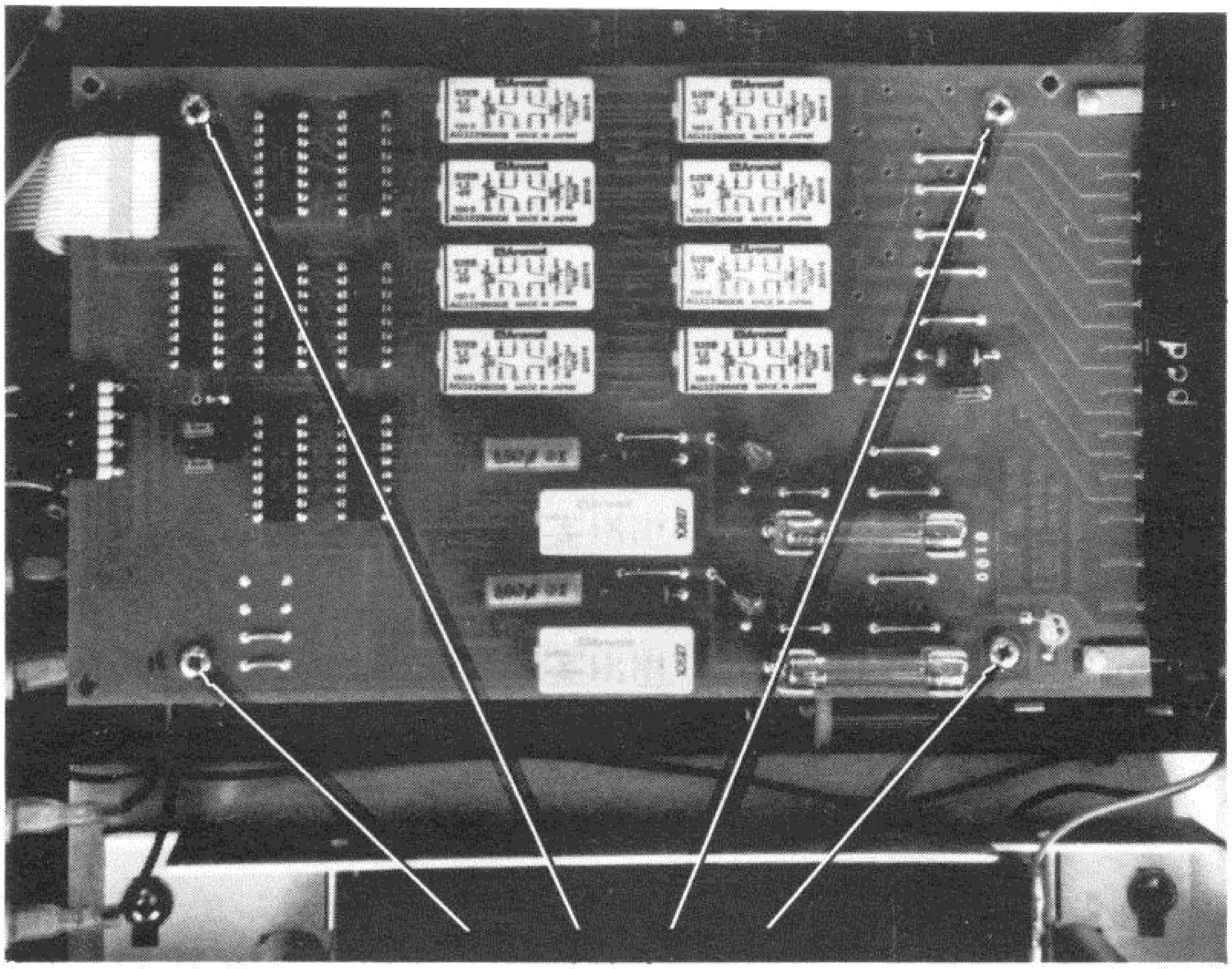


Figure 2-2-5. Removing Hex Screw Standoffs

## NOTE

*The hex standoffs securing the motherboard to the chassis are shorter than the hex standoffs separating the slot 0 and slot 1 options.*

*Some of the first instruments manufactured may have round standoffs that are riveted to the motherboard instead of the screw-in hex standoffs. If the instrument has round standoffs, secure the motherboard to the chassis by using the four loose standoffs that were used to separate the slot 0 and slot 1 options and the four long screws. These must be in place to make the proper ground connection for the motherboard.*

**2-2-13. Slot 2 Option Removal Procedure.** If an option occupies slot 2, do the following:

a. Refer to Figure 2-2-4 and unplug the ribbon cable connector from the option in slot 2. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

b. Locate and remove the four screws holding the option in place.

c. Remove the option from slot 2. To prevent any recalibration of the option, tag the option as option 2 and make sure the same option board is placed back into the instrument into the same slot.

d. If an HP-IB or 12 VDC option is present, do not remove it. Leave all metal shields in place.

### 2-2-14. Option Installation Procedure

2-2-15. This procedure explains how to install the Multiplexer/Actuator Assembly in the instrument. The procedure can be used to install a new assembly or re-install one previously removed.

2-2-16. When re-installing a Multiplexer/Actuator Assembly, make sure it is returned to the same slot from which it was removed. If this is not done, the instrument should be recalibrated for the temperature function of each Multiplexer Assembly occupying a new slot. If a new assembly is being installed, remember to calibrate the temperature function for each slot.

2-2-17. When installing both Multiplexer/Actuator and Digital I/O Assemblies, it is recommended that Multiplexer Assemblies be installed in slots 0 and 1, and the Digital I/O Assemblies in slot 2. If there are three Multiplexer Assemblies, they can be installed in all three slots. That is, install Multiplexer Assemblies in slots 0 and 1, if there is a choice.

2-2-18. The following procedure shows how to install the options in slots 2, 0, and 1, and also how to install the top cover. Keep in mind that if you wish to install an option in slot 1, install the option in slot 0 first. Do the following:

**2-2-19. Slot 2 Option Installation Procedure.** Do the following:

a. If the HP 3421A has an HP-IB or 12 Vdc Power Adapter Option installed and it was not previously removed, place the slot 2 option on top of either the HP-IB or 12 Vdc Power Adapter Option. If the Model 3421A does not have either an HP-IB or 12 Vdc Power Adapter Option, place the slot 2 option directly on top of the bottom shield's standoffs. First, however, make sure the slot 2 option cable is routed as shown in Figure 2-2-6. The cable's red stripe should be oriented to the the right (pin 7 of the motherboard connector).

b. Set the slot 2 option in place with the component side up. Then put the four long screws in place. Do not tighten the screws at this time.

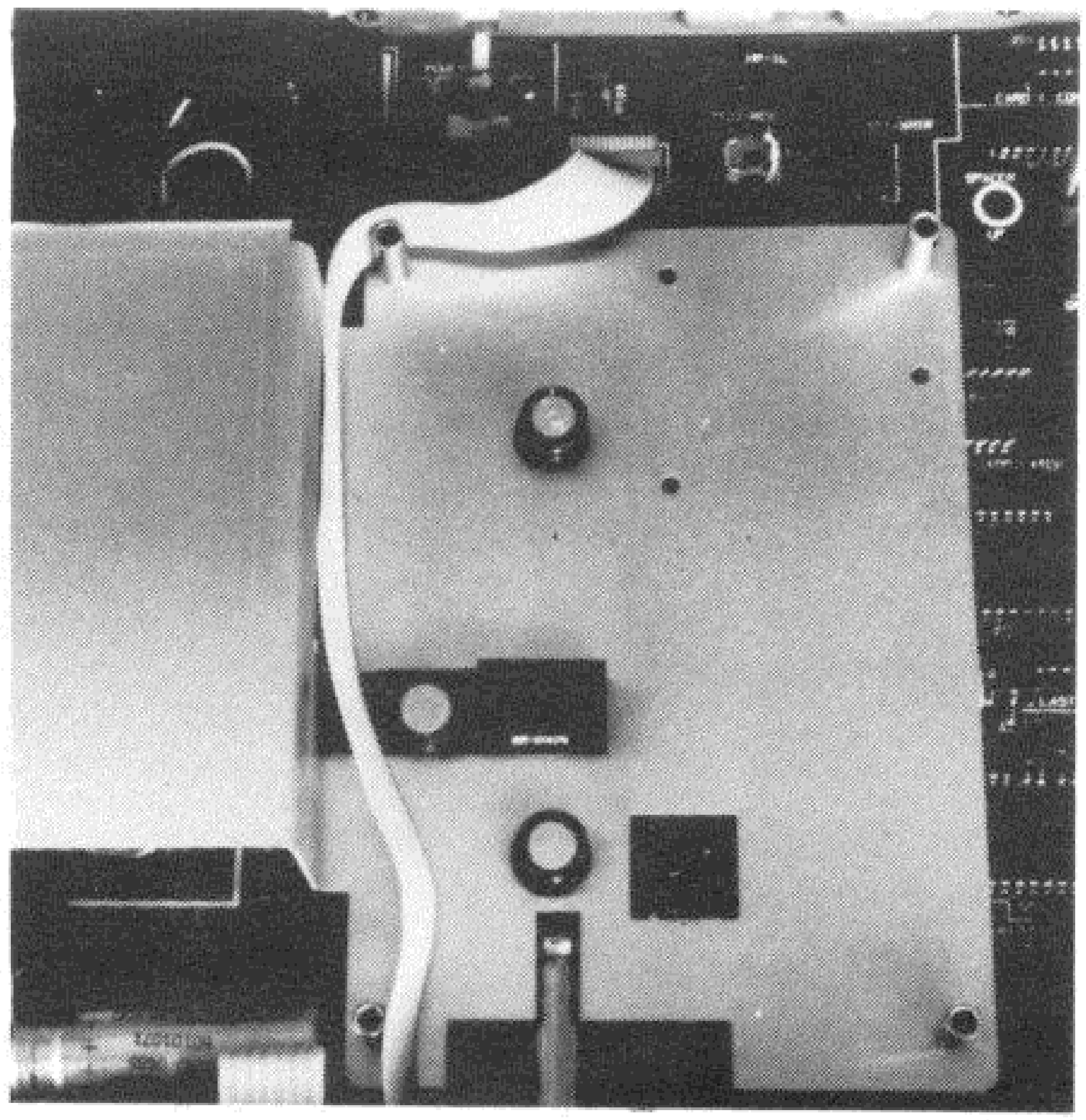


Figure 2-2-6. Slot 2 Option Cable Routing

c. Plug the appropriate terminal block edge connector onto the slot 2 option.

d. Install the rear panel cover for the HP-IB or 12 Vdc Power Adapter Option (if applicable).

e. Install the rear panel cover (i.e., the grey "WARNING" cover) for the slot 2 option.

f. Secure the HP-IB connector (if applicable).

g. Align the slot 2 option so that the strain relief can be screwed into place. Screw the strain relief loosely into place.

h. Tighten the four screws that secure the slot 2 option. Do not overtighten the screws.

i. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 2. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 2 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J100 with the wires oriented as noted on the motherboard.

**2-2-20. Slot 0 Option Installation Procedure.** This option should be installed before installing the slot 1 option. Do the following:

a. Before installing the slot 0 option, make sure that the four motherboard hex standoffs are in place. Do not overtighten these standoffs. Excessive torque (>11 in-lb) could break off the screw heads.

b. Route the ribbon cable for the slot 0 option as shown in Figure 2-2-7.

c. Set the slot 0 option in place, component side up. Make sure the cable underneath is not pinched. Loosely screw the remaining four hex standoffs in place. Do not tighten the four standoffs at this time.

d. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 0. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 0 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J110 with the wires oriented as noted on the motherboard.

e. Plug the appropriate terminal block edge connector onto the slot 0 option.

f. Replace the rear panel grey "WARNING" safety cover for the slot 0 option.

g. Align the terminal block edge connector with the rear panel holes and loosely attach the strain relief for slot 0.

h. Tighten the hex standoffs to secure the slot 0 option. Do not overtighten the standoffs.

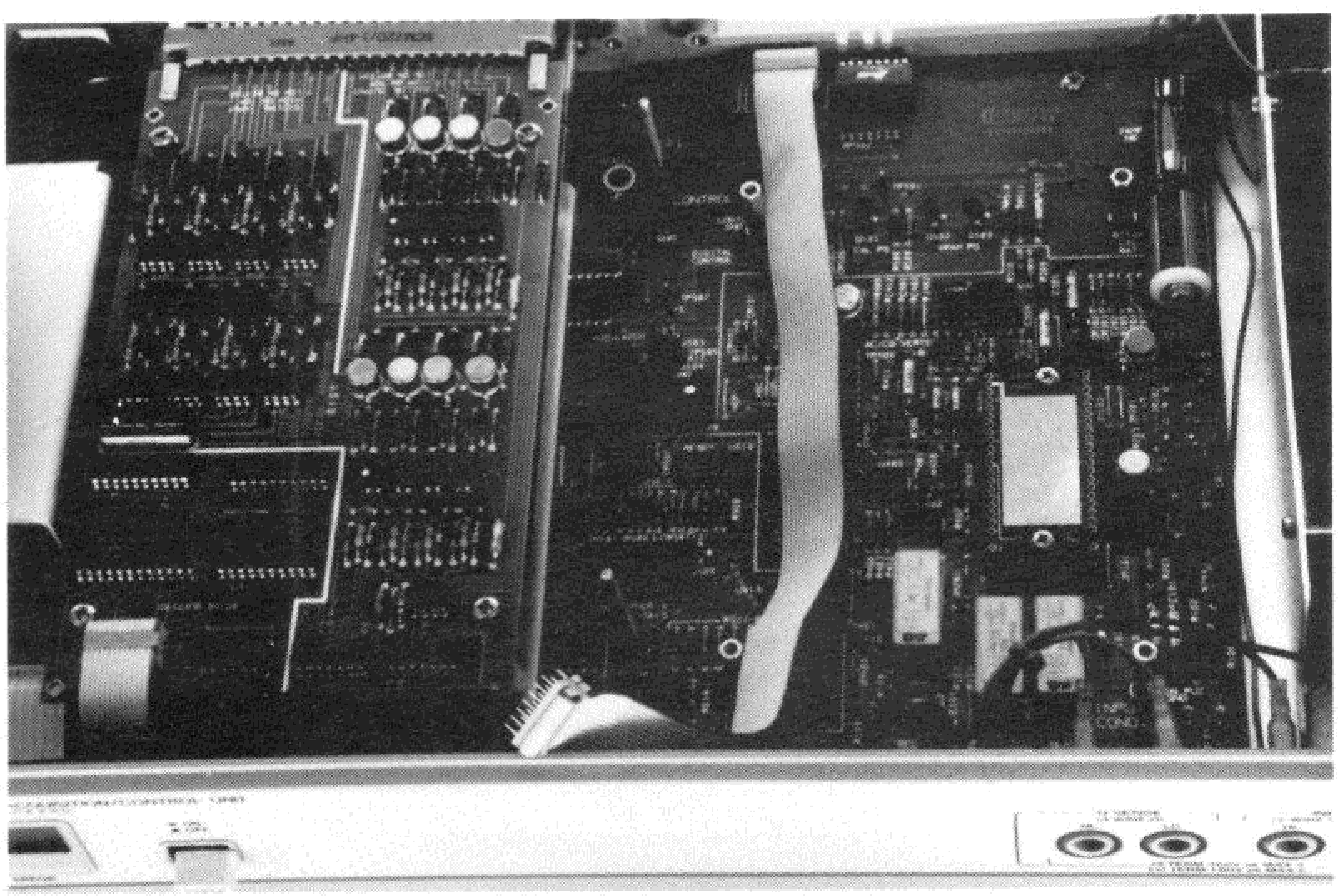


**Figure 2-2-7. Slot 0 Option Cable Routing**

**2-2-21. Slot 1 Option Installation Procedure.** Make sure there is a slot 0 option installed, before installing the slot 1 option. Do the following:

a. Route the ribbon cable from J501 on the motherboard across the slot 0 option as shown in Figure 2-2-8. Make sure the red stripe is oriented to the right (pin 7 of the motherboard connector).

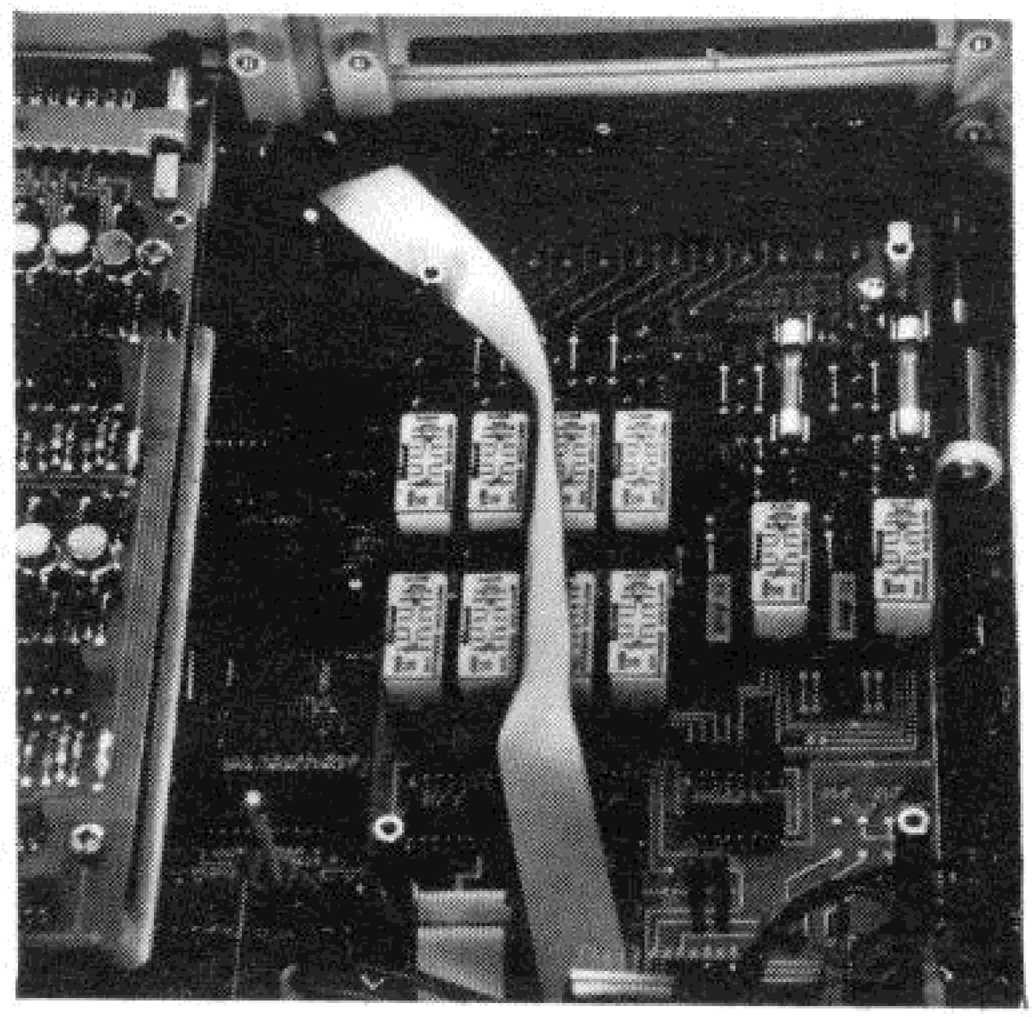


**Figure 2-2-8. Slot 1 Option Cable Routing**

b. Set the slot 1 option assembly in place. Make sure the ribbon cable underneath is not pinched. Then loosely screw four short screws in place. Do not tighten the four screws at this time.

c. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 1. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 1 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J120 with the wires oriented as noted on the motherboard.

d. Plug the appropriate terminal block edge connector onto the slot 1 option.

e. Replace the rear panel grey "WARNING" safety cover for the slot 1 option.

f. Align the terminal block edge connector with the rear panel holes and loosely attach the strain relief for slot 1.

g. Tighten the four screws to secure the slot 1 option. Do not overtighten the screws.

**2-2-22. HP 3421A Top Cover Installation Procedure.** Do the following

a. Before replacing the top cover, first make sure the main battery fuse has been replaced or the red wire to the battery has been reconnected. Then locate the six plastic spacers and place them on the cabinet screws as shown in Figure 2-2-9.

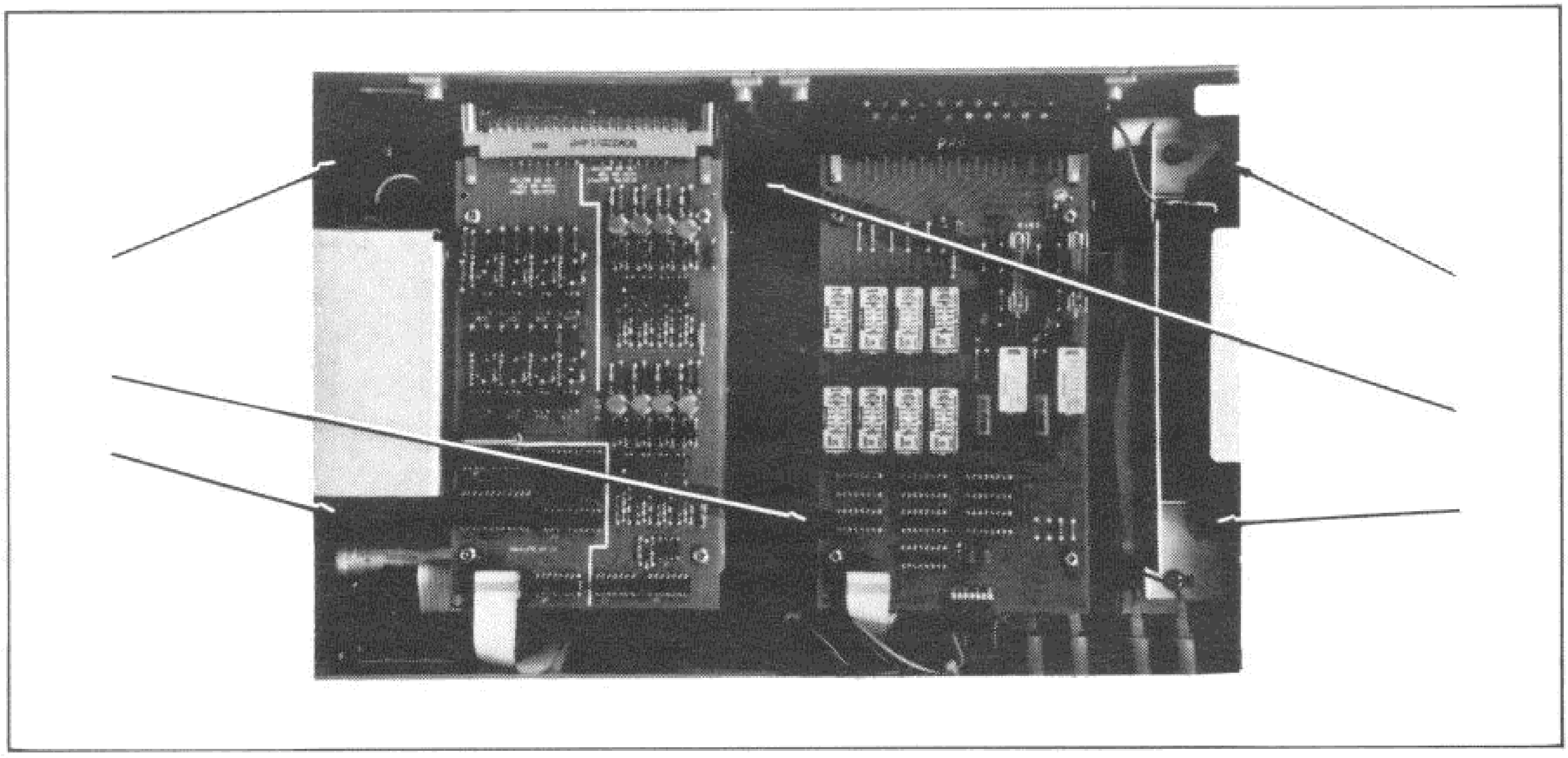


Figure 2-2-9. Plastic Spacer Placement

b. Set the instrument flat on your work bench. Make sure the bale handles on the front feet are collapsed.

c. Align the top cover and lower it in place. If the top cover does not go into place, make sure the front and rear grooves that guide it are properly aligned. If the grooves are aligned, one of the plastic spacers is probably out of alignment. To correct this, alternately move the top cover back and forth (left to right) until the spacers align properly.

d. Once the top cover is in place, hold the two halves of the case together and turn the instrument upside down. Tighten the six bottom screws.

## 2-2-23. STRAIN RELIEF

2-2-24. The black strain relief bar presses wires and cables connected to the terminal block edge connector against a piece of foam on the grey "WARNING" safety cover. This provides strain relief for cables and wires connected to option assemblies.

2-2-25. Figure 2-2-10 shows several wires coming from the terminal block of the slot 2 option. When installing the bar, loosely attach one end first. Hold the other end down and away from the instrument. Leave a small loop in the wires to avoid stress on the terminal block connections. This reduces the possibility of breaking the wires at the strain relief. Then rotate the bar up and connect the other end.

2-2-26. For wires smaller than 22AWG, it is recommended that these wires be bundled together starting at no more than 4" from the back of the instrument. This reduces the possibility of breaking the wires at the strain relief.

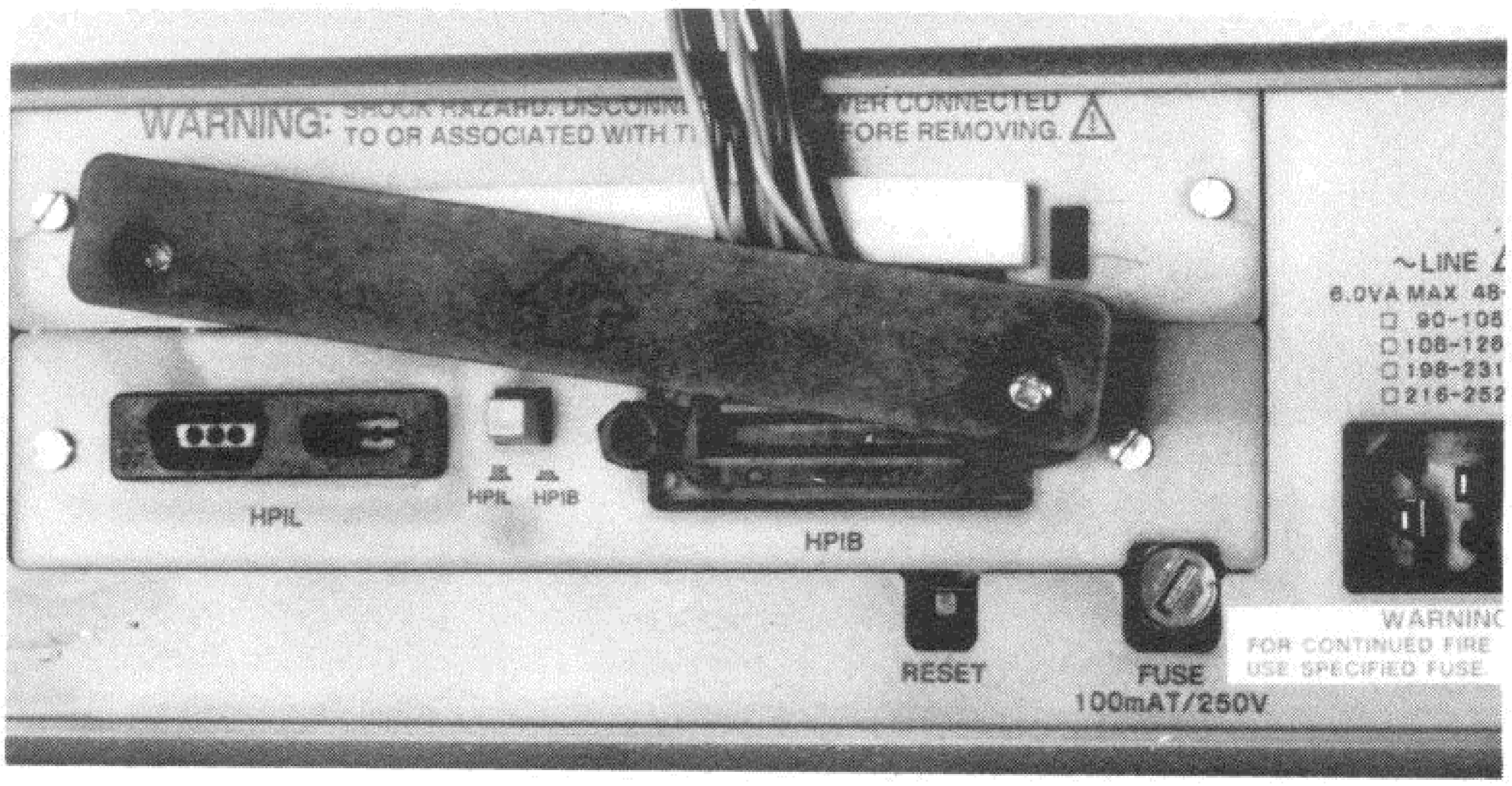



Figure 2-2-10. Strain Relief for Slot 2

## 2-2-27. CONFIGURATION JUMPERS

2-2-28. The Multiplexer/Actuator Assembly has several jumpers that can be divided up into four groups. The first group configures channel 0 and 1 as either actuators or multiplexers. The second group is used by the mainframe to determine the configuration of channels 0 and 1. The third group configures 2-wire or 4-wire Ohms measurements. The last group is used to install attenuators in the signal paths; they can only be used for channels 2 through 7.

### 2-2-29. Actuator/Multiplexer Configuration Jumpers

2-2-30. Several jumpers associated with channels 0 and 1 are used to configure either of these channels as a multiplexer or actuator. Figure 2-2-11 shows the location of these jumpers for both older assemblies (with no ERC number, or ERC 2334 and below) and newer assemblies (ERC 2421 and above). The older assembly is shown in Figure 2-2-11,A and the new assembly is shown in Figure 2-2-11,B. The jumpers in Figure 2-2-11,A need to be cut and a new jumper soldered in to change the configuration. The jumpers in Figure 2-2-11,B are flying lead jumpers that can easily be unplugged and plugged in to change the configuration.

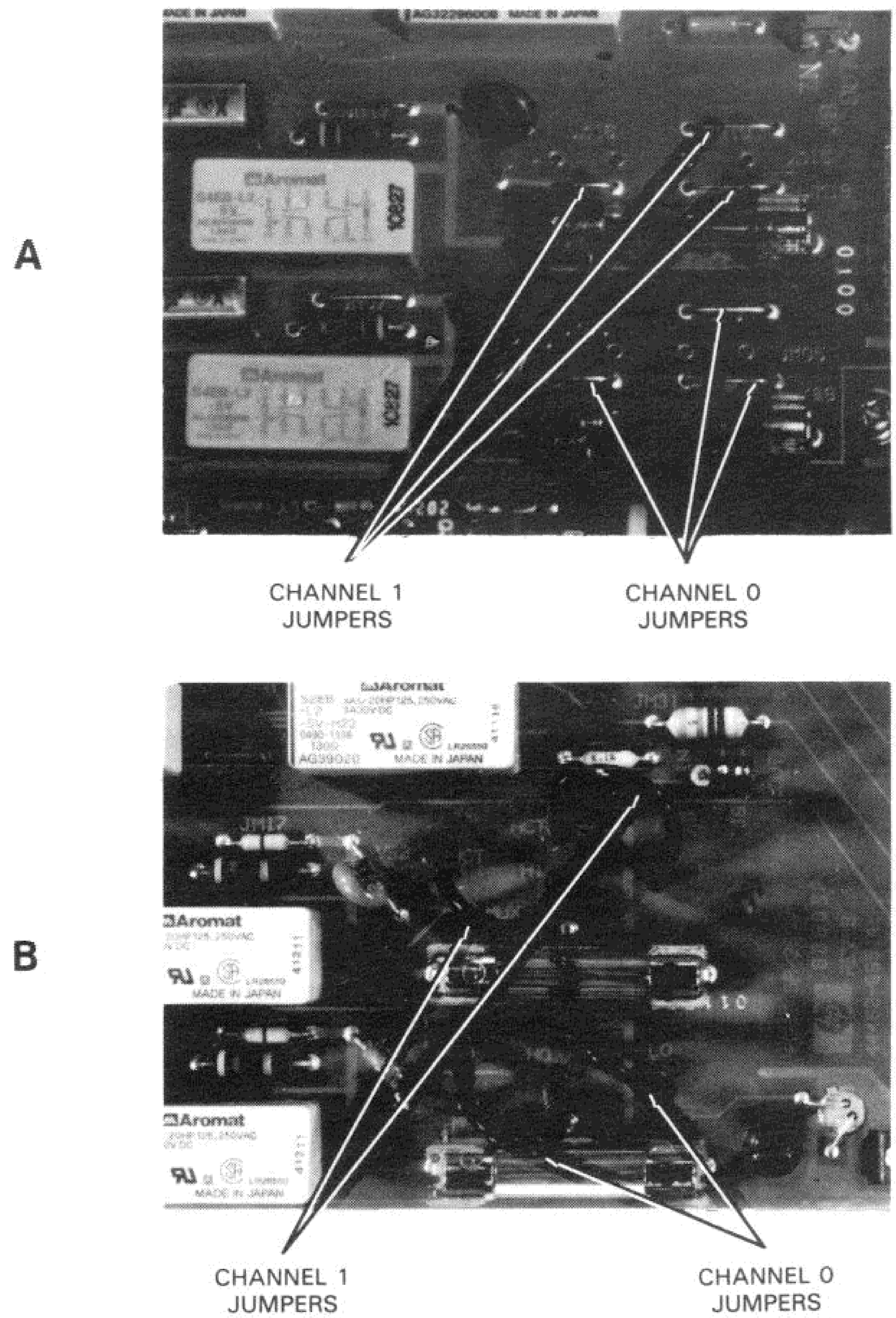
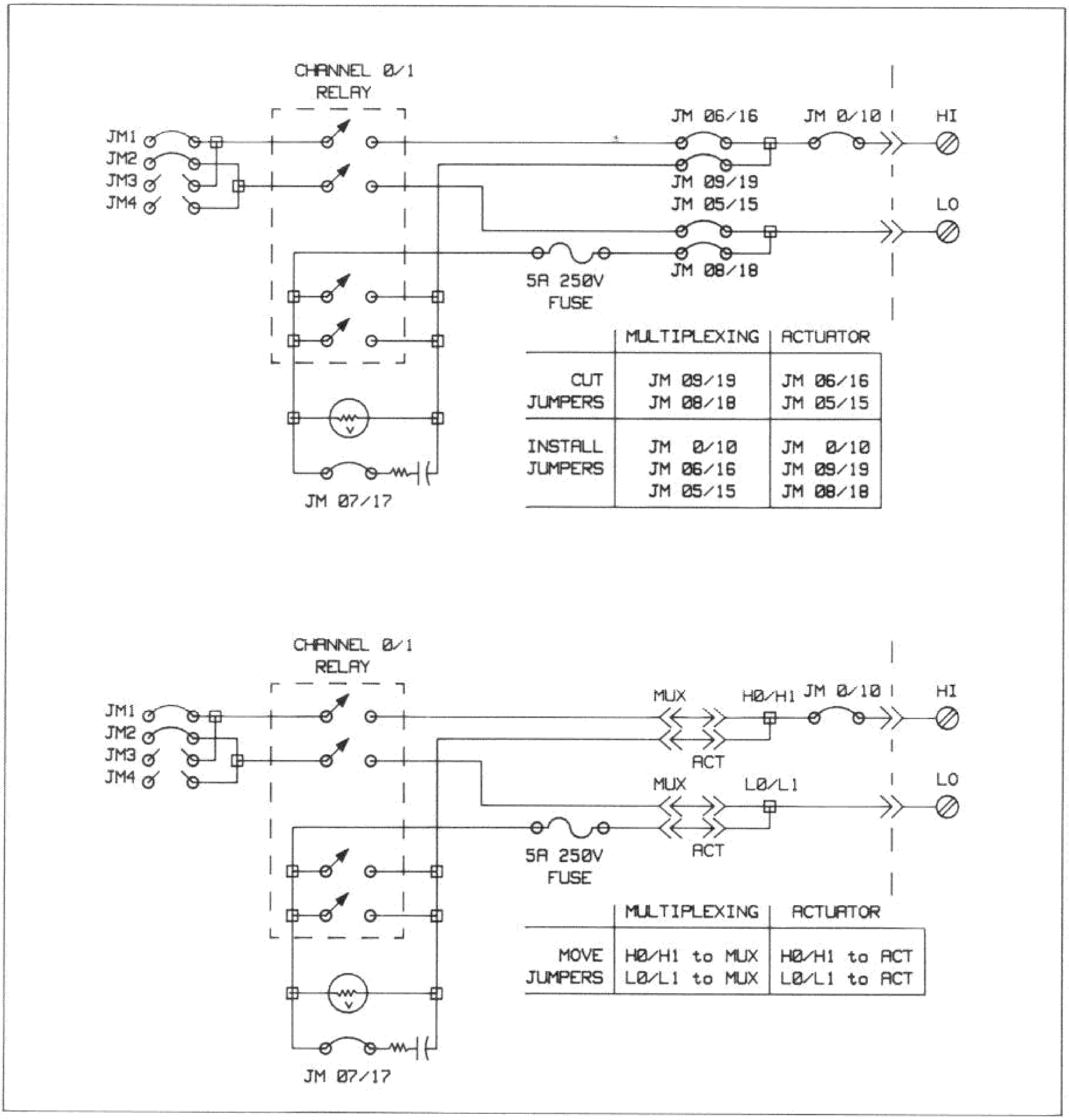



**Figure 2-2-11. Multiplexer/Actuator Jumper Locations for Channels 0 and 1**

2-2-31. Figure 2-2-12 shows schematically which jumpers need to be selected to configure either channel 0 or 1 as a multiplexer or actuator. The figure shows how to configure both older assemblies (with no ERC number, or ERC 2334 and below) and newer assemblies (ERC 2421 and above). The older assembly configuration is shown in Figure 2-2-12,A and the new assembly configuration is shown in Figure 2-2-12,B.




| | MULTIPLEXING | ACTUATOR |
|---|---|---|
| CUT JUMPERS | JM Ø9/19<br>JM Ø8/18 | JM Ø6/16<br>JM Ø5/15 |
| INSTALL JUMPERS | JM Ø/1Ø<br>JM Ø6/16<br>JM Ø5/15 | JM Ø/1Ø<br>JM Ø9/19<br>JM Ø8/18 |

| | MULTIPLEXING | ACTUATOR |
|---|---|---|
| MOVE JUMPERS | HØ/H1 to MUX<br>LØ/L1 to MUX | HØ/H1 to ACT<br>LØ/L1 to ACT |

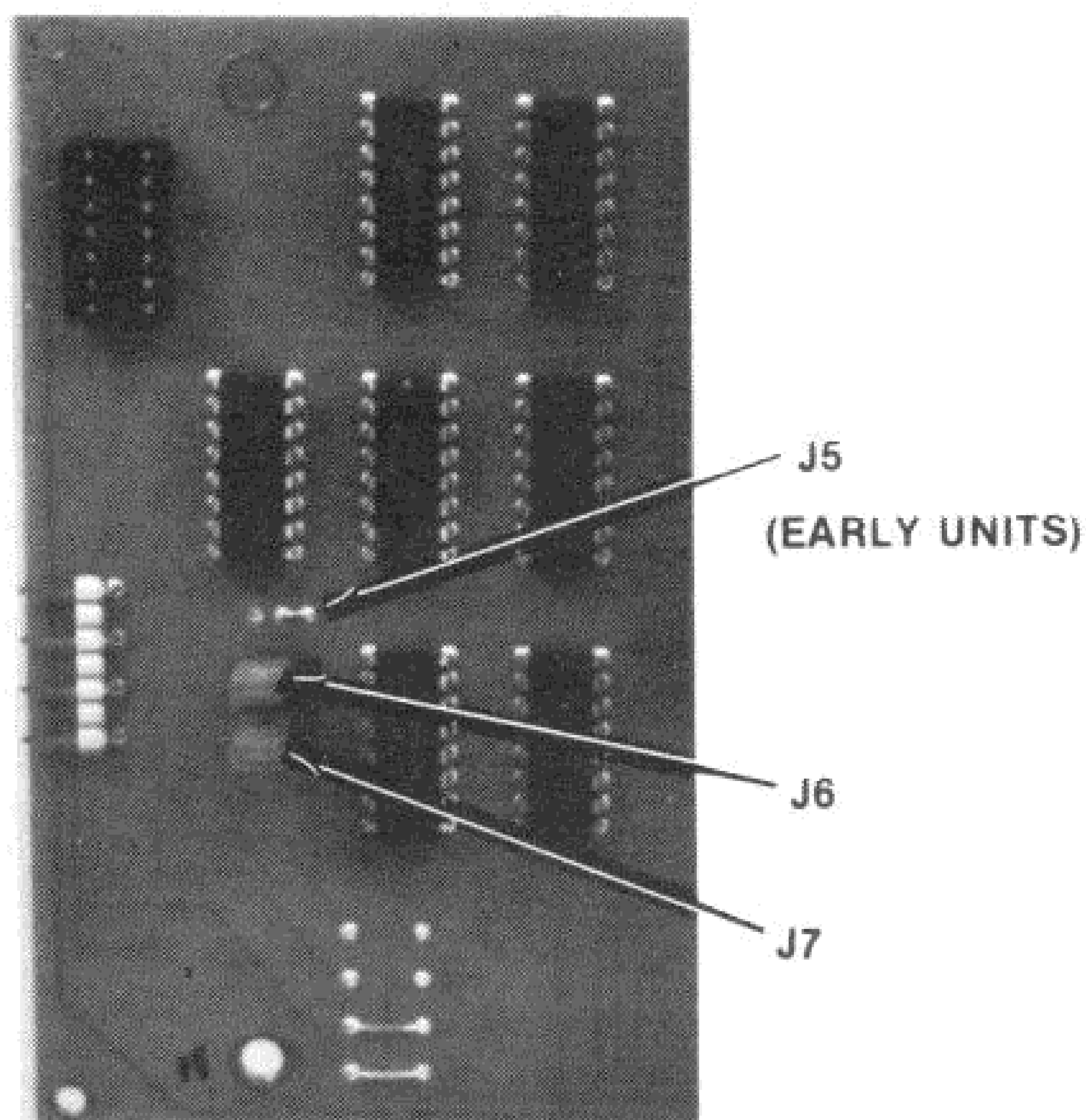
**Figure 2-2-12. Configuring Channels 0 and 1 as Multiplexer/Actuator**

2-2-32. In Figure 2-2-12,A, each jumper is labeled twice. The smaller number is the jumper associated with with channel 0; the larger number is the jumper for channel 1 (i.e., JM0 is for channel 0; JM10 is for channel 1).

2-2-33. As shown in Figure 2-2-12,B, connect the appropriate jumpers to either ACT for an actuator configuration or to MUX for a multiplexer configuration. The H0 and L0 jumpers are for channel 0 and the H1 and L1 jumpers are for channel 1.

## 2-2-34. Jumpers to Identify Multiplexer/Actuator Configuration

2-2-35. The next set of multiplexer/actuator jumpers are actually jacks J6 and J7. They are used by the mainframe to identify the configuration of channels 0 and 1. See Figure 2-2-13 for the location of the jumpers. After channels 0 and 1 are configured to your needs, J6 and J7 must be set accordingly. If J6 and J7 are incorrectly configured, an error may result. For example, if channel 1 is configured as a multiplexer but J6 and J7 identify it as an actuator, an error will result if a measurement is attempted from channel 1.




| J6 | J7 | Configuration |
|---|---|---|
| 0 | 0 | Channel 0-9 are multiplexers |
| 0 | 1 | Channel 0 is an actuator, all others are multiplexers |
| 1 | 0 | Channel 1 is an actuator, channels 0 and 2-9 are multiplexers |
| 1 | 1 | Channels 0 and 1 are actuators, all others are multiplexers |

**Figure 2-2-13. Jumpers to Identify Multiplexer/Actuator for Channels 0 and 1**

2-2-36. As shown in Figure 2-2-13, there are four possible combinations for the configuration of multiplexer and actuator channels. If both channels 0 and 1 are selected as actuators, both J6 and J7 are in the "1" position. If you have an older assembly, it may also have a J5 (J5 is located next to J6). If this is the case, J5 should always be set to the "0" position. This is very important, because, if J5 is in the "1" position, the mainframe will not recognize the existence of the assembly or recognize it as a Digital I/O Assembly. This could be confusing when closing channels or making measurements.

### 2-2-37. 2-Wire and 4-Wire Ohms Jumpers

2-2-38. There are four jumpers used to configure for either 2-Wire Ohms or 4-Wire Ohms measurements. These jumpers are shown in Figure 2-2-14. To configure a Multiplexer/Actuator Assembly for 2-Wire Ohms, remove jumpers JM3 and JM4. For 4-Wire Ohms measurements, two Multiplexer/Actuator Assemblies are required. On one assembly, remove jumpers JM3 and JM4 and install jumpers JM1 and JM2. This assembly serves as the Ohms Current Source. On the other assembly, remove jumpers JM1 and JM2 and install jumpers JM3 and JM4. This assembly serves as the sense multiplexer. (Note: This assembly is not now capable of making any measurements other than 4-Wire Ohms.)

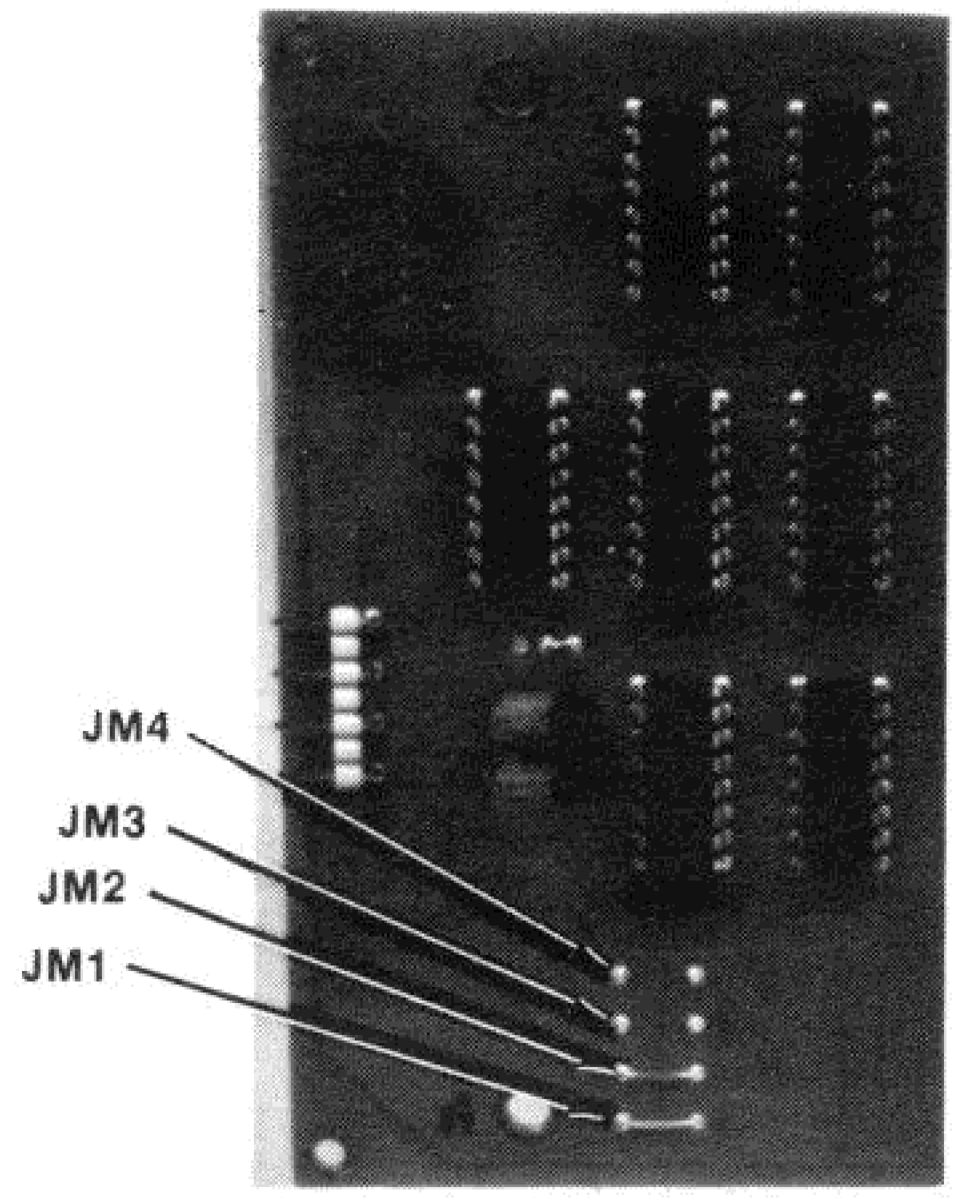



**Figure 2-2-14. 2-Wire and 4-Wire Ohms Configuration Jumpers**

### 2-2-39. Attenuators

2-2-40. An attenuator is composed of two resistors which serve as a voltage divider (see Figure 2-2-15). Provisions are provided on the circuit board for attenuators to be installed on channels 2 through 7. On board provisions are not provided for attenuators on channels 0, 1, 8 and 9.

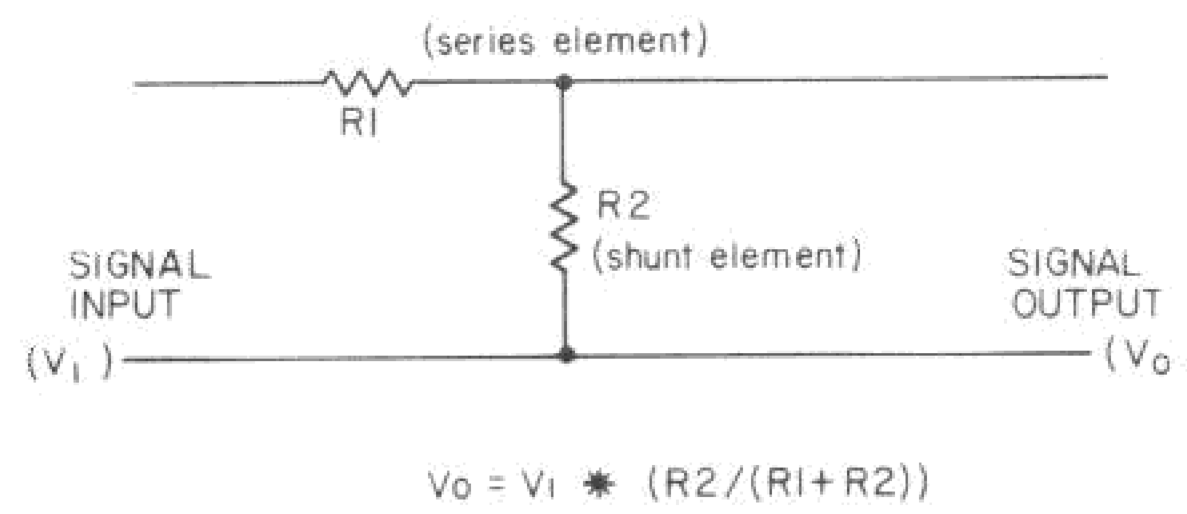



**Figure 2-2-15. Attenuators**

2-2-41. Channel 2 on each Multiplexer/Actuator Assembly has a built-in jumper selectable, 10:1 attenuator. When this attenuator is in the circuit, it provides an input impedance of approximately 1MΩ (R20 + R21). This attenuator is normally bypassed and can be selected by moving J8 from the "OUT" to the "IN" position.

2-2-42. Channels 3 through 7 can all have attenuators added to their respective signal paths. Figure 2-2-16 shows how this is done. A package of seven resistor pairs (HP Part Number 44469A) is available for use as attenuators. These resistors have the same values as those used in channel 2 (101.5K and 900K).

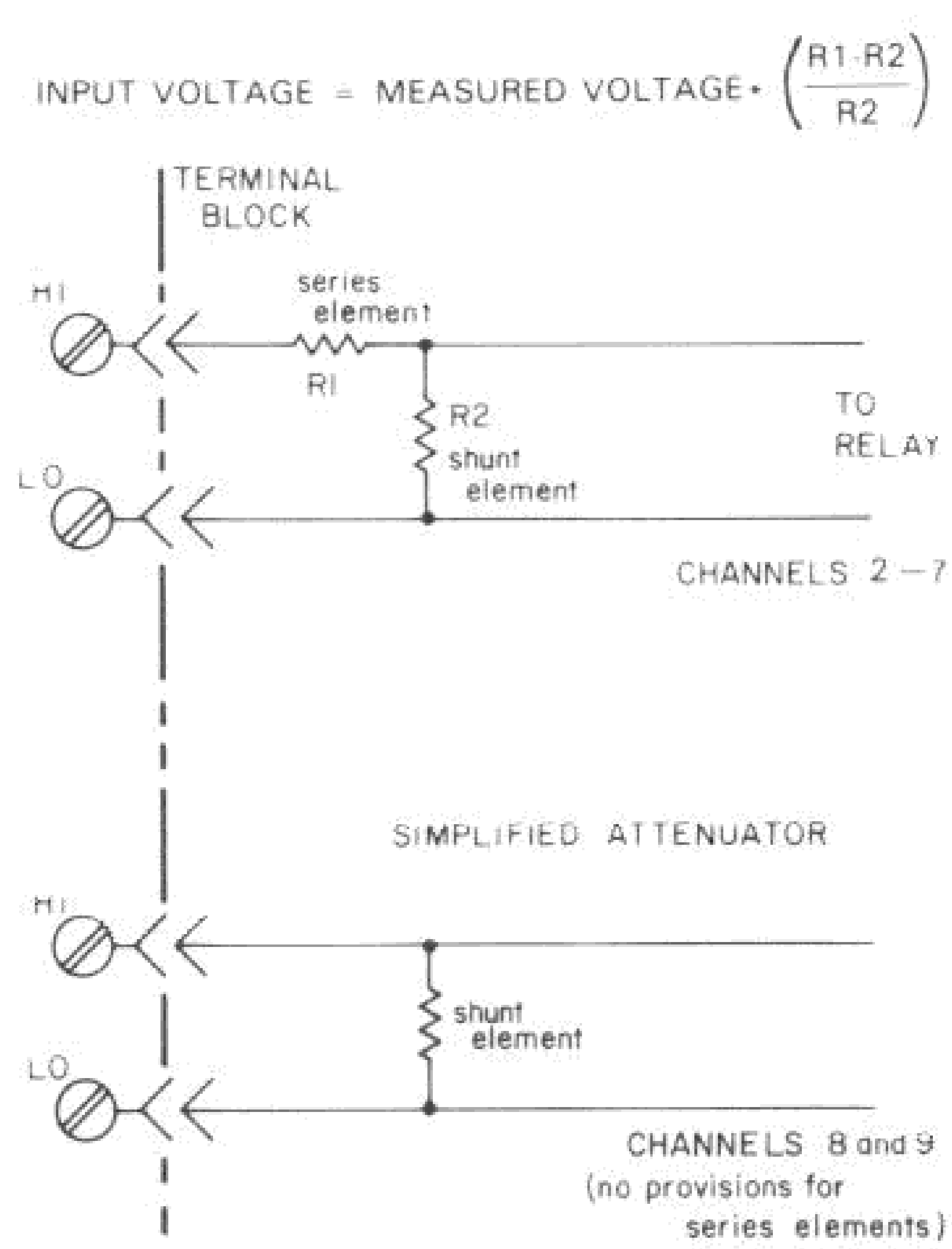



**Figure 2-2-16. Adding Attenuators to Channels 3 through 7**

2-2-43. Channels 8 and 9 can only have shunt elements added to their signal paths. One example where this may be applicable is with 4-20mA transducers. A 50Ω resistor, ±.1%, .5W (HP Part Number 0699-0064), can be placed across the signal path. The resultant voltage drop (transducer current through the resistor) can be measured by the internal voltmeter of the instrument. The 50Ω resistor converts the 4-20mA current to a 0.2-1V voltage.

2-2-44. Refer to Figure 2-2-17 to locate where attenuators are placed for the various channels. It may also be helpful to refer to the schematic diagram.

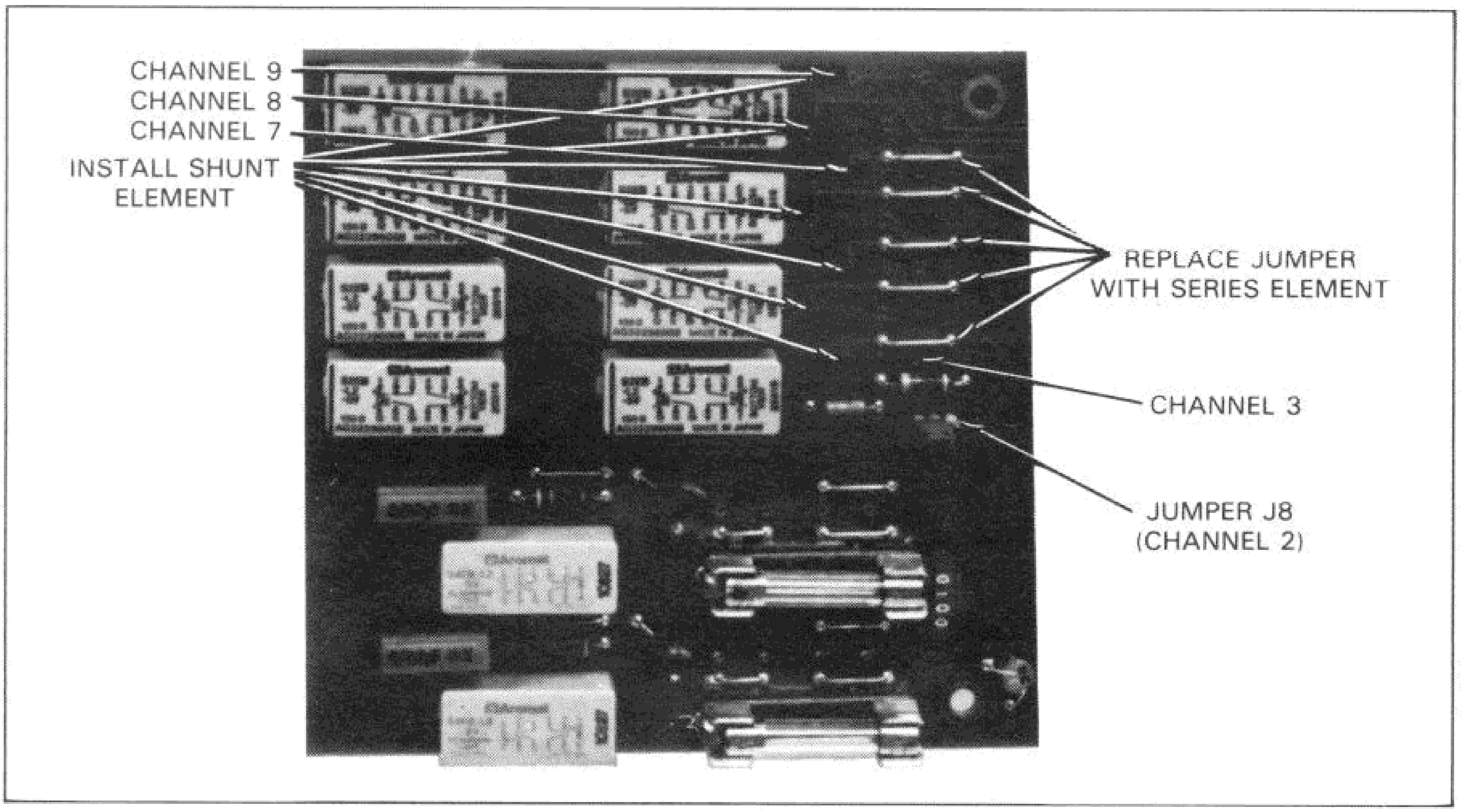



**Figure 2-2-17. Attenuator Placement**

## 2-2-45. TERMINAL BLOCK EDGE CONNECTOR

2-2-46. Figure 2-2-18 shows the channel connection sequence for the terminal block. Extra terminal blocks are available by ordering HP Part Number 44463A. Note that the HI and LO COMMON terminals are un-multiplexed inputs connected directly to the voltmeter HI and LO inputs.

2-2-47. When installing the terminal block on the Multiplexer/Actuator Assembly, make sure it is firmly seated and square against the multiplexer circuit board. Hand tighten the captive screws into the circuit board clevis. Bundle all wires smaller than 22 gauge starting no more 4'' from the terminal block.

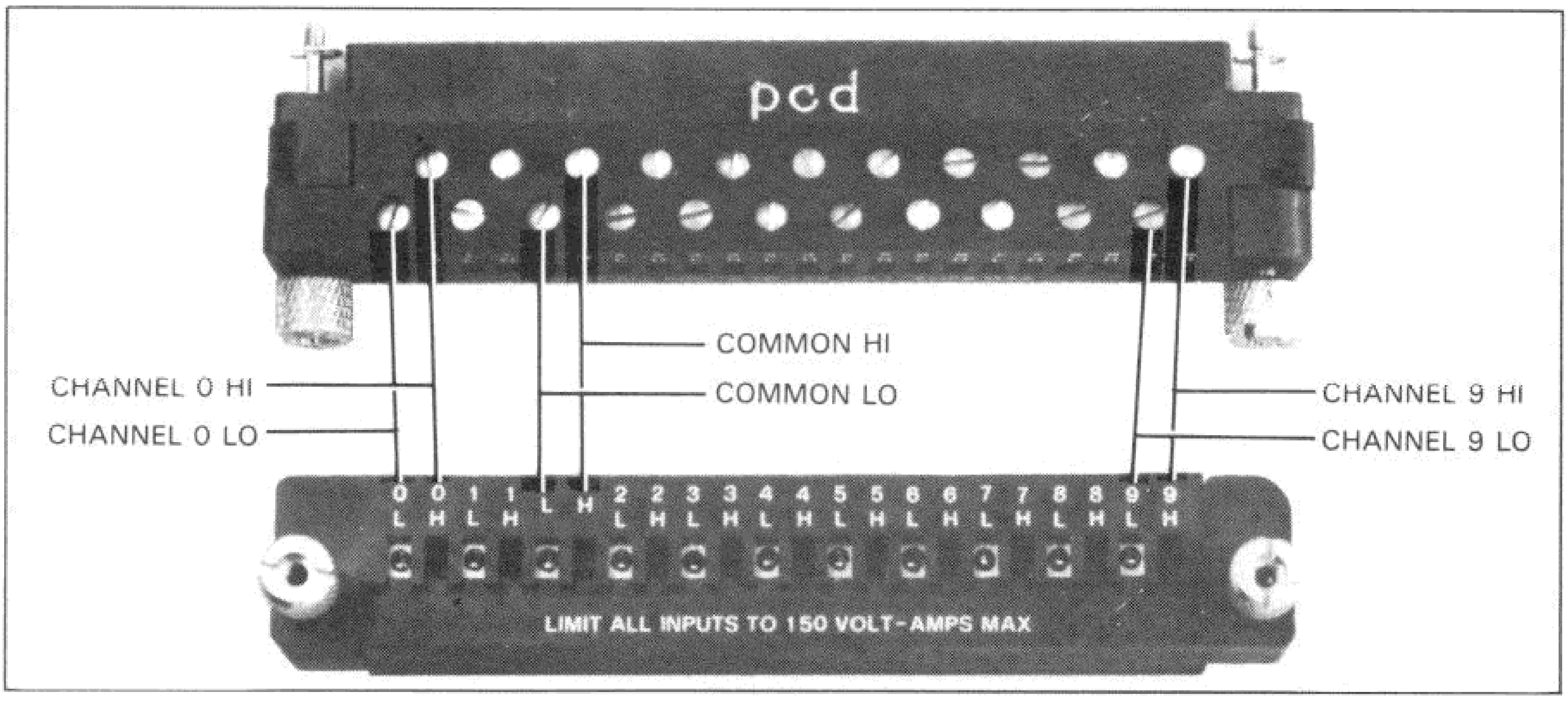



**Figure 2-2-18. Terminal Block Connection Sequence**

### 2-2-48. CLEANING

2-2-49. The circuit board should be cleaned when measurements under high humidity (>80%) and/or temperature (>30°C or >90°F) conditions are to be made. The terminal block edge connectors should be cleaned when very high resistance or voltage measurements in a high impedance circuit are to be made. Use the following procedure to clean the circuit board and/or the terminal block edge connector.

a. Remove all sources of power from the option assemblies.
b. Remove the Multiplexer/Actuator Assembly from the instrument (see paragraph 2-2-8).
c. Wash the circuit board and/or the terminal block edge connector with isopropyl alcohol.
d. Rinse thoroughly with de-ionized water.
e. Dry completely before re-installing in the instrument.

# SECTION III
# OPERATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 2-3-1. INTRODUCTION

2-3-2. This section contains the operating information for the Multiplexer/Actuator Assembly. This operating information is abbreviated, and is provided for the service trained individual, rather than an operator.

## 2-3-3. GENERAL INFORMATION

### 2-3-4. Power Requirements

2-3-5. The Multiplexer/Actuator Assembly obtains its power from the mainframe via the ribbon cable connector that plugs into J4. On the mainframe, this ribbon cable plugs into either J500, J501, or J502, depending upon which slot the Multiplexer Assembly occupies. The power supplies used include VB, +5V, and +15V.

### 2-3-6. Information Transfers

2-3-7. When operating with HP-IL, most commands will "hold-up" the computer until all readings have been taken. For example, suppose you have three Multiplexer/Actuator Assemblies installed and you program the instrument to take 30 readings (one reading from each channel). With a reading rate of about two per second, 15 seconds are required to take all 30 readings. The computer can not perform any task while the instrument is making the measurements.

2-3-8. With the HP-IB Option installed, a switch on the option enables and disables buffered transfers. This switch is factory reset to disable buffered transfers (switch up). In the up position, the HP-IB interface acts similar to the HP-IL interface, holding up the computer until all measurements are made. With the switch in the down position, buffered transfers are enabled. This releases the computer while the instrument is making measurements. However, if the computer attempts a subsequent communication operation on the HP-IB interface with the HP 3421A present, the transfer will be held until the measurement function is complete. The buffered transfer mode provides the fastest transfer of information.

### 2-3-9. Commands

2-3-10. Commands sent to the instrument instruct it to perform some specified task. At the end of this section is a list of commands that are used with the Multiplexer/Actuator Assembly. Commands fall into two categories: standard and advanced.

a. Standard commands set up the instrument and then complete a measurement task. For example, the command DCV2,7-9 causes the instrument to take DC Voltage measurements on channels 2, 7, 8, and 9, and store the readings in its internal memory. One command causes a complete measurement task to be performed.

b. Advanced Commands provide additional flexibility, but they do not perform a complete measurement task. These commands perform only one aspect of a measurement. Advanced commands are suitable for those who wish to tailor their system for some particular requirement.

### 2-3-11. Channel List Rules

2-3-12. The channel list specifies the order in which channels will be measured. The series of channels specified must follow these rules.

a. The default channel list (asserted at power on or reset) consists of all multiplexer channels in numerical sequence. The channel list can be loaded with multiplexer channels by the DCV, ACV, TWO, FWO, TEM, FRQ, LS or LP commands. It can also be loaded with digital input bit numbers by the BIT command.

b. Channel addresses are separated by commas. However, a dash may be used to signify a contiguous set of channels. When using Advanced Commands, any command that specifies a channel must be separated from subsequent commands by either a colon (:) or a semicolon (;) but not a comma (,). Example: F1RA1Z1N5LS5-9;T3. If the last character in the command string is a comma, an error will be generated.

c. No more than 30 channels are accepted into the channel list. Legal channel numbers are 00 through 29.

d. The mnemonic determines what type of channel can be loaded into the channel list. In other words, if channel 1 is configured as an actuator channel, it should not be specified for any type of measurement (i.e., DCV1 or BIT1). If an attempt is made to load the channel list with an improper type of channel, a syntax error is generated and the command is aborted. If channels x-y are received and some channels in between and including x and y are the wrong type of channels for the command, they are not loaded into the list and the error message is not sent. The remainder of the channels are loaded into the list.

e. Leading zeros are ignored. Example: DCV00019 means DCV19.

f. All syntax following a decimal point is ignored except for comma (,), dash (-), semicolon (;), colon (:), carriage return (CR), or line feed (LF). Example: DCV2.3 means DCV2.

g. Exponents are not allowed and cause a syntax error. The command is also aborted.

h. All lower case letters are interpreted as upper case. Blanks and the plus sign (+) are ignored. Commas and minus signs are used as channel number separators. The minus sign is also used to specify the lowest range and shortest gate time. Colons and semicolons are used as terminators. All other punctuation cause a syntax error. In other words, DcV 21 is the same as DCV21.

i. Terminators are required after any command (Standard or Advanced) that either specifies a channel or a decimal value, when that command is to be followed by another command. For example, the 'Mx' command is used to set the SRQ mask. This command can have a decimal integer value 'x' of between 0 and 255. Therefore, this command must be followed by a terminator if another command is to follow it. Example: OUTPUT 901 ; "M1;T0". Valid terminators are a colon (:), semicolon (;), carriage return (CR) or line feed (LF).

# Multiplexer/Actuator Assembly Command Guide

Commands fall into one of two categories: Standard and Advanced. Each Standard Command performs a complete measurement or function while two or more Advanced Commands are generally required to perform a measurement.

[ ] means optional channel list
< > means mandatory channel list

**Standard Commands**

**DCV [x,y,...z]** DC Volts. Sets the voltmeter to DCV (F1), Autorange (RA1), Autozero on (Z1), 5 1/2 digits resolution (N5). If no channel list is sent, the channel list is not changed but software single trigger is executed (T2). If channel list is sent, they are loaded in order received then a reading is made and stored from each channel in sequence (T3). DCV always opens the last channel before closing the next channel in the list. It exits with the last channel in the list closed unless no numbers were received then it exits with the channels in the same state they were in prior to the command. When the instrument is addressed to talk, all readings will be sent in the sequence they were taken.

**ACV [x,y,...z]** Same as DCV but for AC Volts (F2) and 4 ½ digit resolution (N4).

**TWO [x,y,...z]** Same as for DCV but for 2-wire Ohms (F3) measurements.

**FWO [x,y,...z]** Same as for DCV except for 4-wire Ohms (F4) measurements. Channels are automatically paired with x+10, y+10,...z+10 unless x,y,...z are between 20 and 29 in which case they are paired with x-20, y-20,...z-20. Pairs are closed simultaneously.

**TEM [x,y,...z]** Same as for DCV but for temperature measurements (F6) and does a software compensated T-type thermocouple conversion. Result returned is in Degrees C. TEM will take a REF temperature measurement on the HP 44462A assembly in the lowest numbered slot if no channel numbers are sent.

**REF [x]** Measures the temperature of the REFerence junction (F5) on HP 44462A assembly where channel 'x' is. If 'x' is not sent, then defaults to assembly where a multiplexer channel is closed. If no channel is closed, then selects HP 44462A assembly in lowest numbered slot. Result returned in Degrees C.

**FRQ [x,y,...z]** Measures FReQuency (F7) with a 1 second gate time (G0), 5 ½ digits resolution (N5). If no channel numbers are sent, the channel list is not changed and no channels are opened or closed. A software single trigger (T2) is executed. If channel list s sent they are loaded in the order received and a reading is is made and stored from each channel in sequence. When addressed to talk, all readings will be sent in the sequence they were taken.

**TOT [x]** TOTalizes events (F7) up to a maximum count of 65,535. If channel 'x' is sent, all channels will be opened before closing channel 'x'. The counter will be zeroed and then starts totalizing. If 'x' is not sent, then the counter is zeroed and starts totalizing without changing channels. Channel 'x' will remain closed until another command opens it. When the instrument is addressed to talk, it will send out the current subtotal without disrupting the counter. NOTE: if a TRIGGER command is received, the TOT is aborted and a frequency reading is made.

**CLS<x>** CLose Single channel 'x'. The instrument first identifies the type of channel at 'x' and then if 'x' is:

an Actuator - closes channel x. Possible actuator channel numbers are: 00,01,10,11,20,21).

a Digital Output Bit - closes it.

a Multiplexer - opens all multiplexer relays and closes channel 'x'.

**CLP<x>** CLose a Pair of channels. The instrument will open all multiplexer relays and then close channels x and x+10. If x ≥ 20, then x and x-20 will be closed. If either x or its pair is not a multiplexer channel, then no channels are closed or opened and an error is generated.

**OPN[x]** Open channel(s). If channel 'x' is not sent, then the OPN command will open all channels digital outputs, actuators, and multiplexers. If 'x' is sent, the instrument identifies the channels and if 'x' is:

an Actuator - opens it.

a Digital output - clears bit 'x'

a Multiplexer - opens it. This includes channels closed by the UC command. If 'x' was closed as a pair (i.e., CLPx) then its pair will be opened also.

**Advanced Commands**

| Function, Command | R-1 | R0 | R1 | R2 | R3 | R4 | R5 | R6 | R7 |
|---|---|---|---|---|---|---|---|---|---|
| | Range Codes (RA1 = Autorange on, RA0 = off) | | | | | | | | |
| All functions off, F0 | x | x | x | x | x | x | x | x | x |
| DC Volts, F1 | .3V | 3V | 30V | 300V | ← | ← | ← | ← | ← |
| AC Volts, F2 | → | 3V | 30V | ← | ← | ← | ← | ← | ← |
| 2-Wire Ohms, F3 | → | → | → | 300Ω | 3kΩ | 30kΩ | 300kΩ | 3MΩ | 30MΩ |
| 4-Wire Ohms, F4 | → | → | → | 300Ω | 3kΩ | 30kΩ | 300kΩ | 3MΩ | 30MΩ |
| REFerence, F5 | x | x | x | x | x | x | x | x | x |
| TEMperature, F6 | x | x | x | x | x | x | x | x | x |
| FReQuency, F7 | Gate time: G-1 = .1S, G0 = 1S, G1 = 10S | | | | | | | | |

Voltmeter Autzero: Z0 = Auto-zero off, Z1 = Auto-zero on.

Number of digits of resolution: N3 = 3 1/2, N4 = 4 1/2, N5 = 51/2

Trigger: T0 = Hold trigger and enable channel list scan
T1 = Internal trigger
T2 = Software single trigger
T3 = Triggers measurements from channel list and stores readings
DTa = Digital Trigger, does a T3 when digital input bit 'a' goes low.

LS<channel list> Load Single channels into channel list.

LP<channel list> Load channel Pairs into channel list.

M[decimal integer number] Set SRQ Mask.

RL Read channel List.

RS ReSet.

SI<0 or 1> SI0 = Initialize channel list pointer to beginning of list. SI1 = opens channel and closes next channel in list. Must be an integer value.

SR Read Status Registers.

UC<channel number> Unconditionally Close specified channel.

# SECTION IV
# PERFORMANCE VERIFICATION AND CALIBRATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 2-4-1. INTRODUCTION

2-4-2. This section contains the performance verification procedures for the Multiplexer/Actuator Assembly. The performance verification is explained first, followed by the calibration procedure. A Diagnostic Terminal Block (P/N 03421-66504) can be used to run verification tests on the HP 44462A Multiplexer/Actuator Assembly. This is done using an HP-41C/CV Handheld Computer or an HP-85 Personal Computer. The HP-41C/CV must be equipped with the HP 44468A Data Acquisition Pac ROM to use the test fixture. To use the fixture using an HP-85, you must have the HP 3056DL software package or the HP 3421A Calibration and Test Tape Cartridge (P/N 03421-10001, Rev. C or above).

## 2-4-3. RECOMMENDED EQUIPMENT

2-4-4. All recommended equipment for the performance tests and temperature calibration procedure is listed in Table 2-4-1.

**Table 2-4-1. Recommended Equipment**

| Instrument | Critical Specifications | Recommended Model | Use* |
|---|---|---|---|
| Digital Voltmeter | Range: .1 Volt/.1 Ohm<br>Accuracy ±.005%<br>Temp. Math Function | HP Model 3456A | PC |
| Computer | | HP Model 85A with I/O ROM and Application ROM<br>HP Model 85B with I/O ROM | P |
| 10 Vdc Power Supply | | | PC |
| Temperature Calibrator Board | | HP P/N 03421-66505 | C |
| *P = Performance C = Calibration | | | |

2-4-5. The procedures assumes that the computer I/O interface is set to select code "9". If the interface is "HP-IB", the HP 3421A must have the HP-IB Option installed with the address switches set to "01". If the interface is HP-IL, the HP-85 will automatically assign address "01" to the Model 3421A if it is the first device on the loop. All commands in the procedure use address "901" (9 + 01).

## 2-4-6. PERFORMANCE TESTS

2-4-7. The performance tests check the contact resistance of the relays, thermal offset voltage, and the attenuator on channel 2.

2-4-8. The multiplexer can be installed in either slot 0, slot 1, or slot 2 to run the tests. The top cover can be removed while performing the tests, if desired. If the option to be tested is in slot 0, you must remove any option occupying slot 1 before starting the test. Thus, if you have a Multiplexer/Actuator Assembly in slot 0 and slot 1, always do the entire performance verification for the slot 0 option first. Then replace the slot 1 option and do the performance verification for it next.

**IMPORTANT**

*If a Multiplexer/Actuator Assembly is removed while performing any of these tests, make sure it is re-installed in the slot from which it was removed. This is necessary because each reference junction on each Multiplexer/Actuator Assembly can be slightly different, resulting in unique calibration constants for each assembly.*

2-4-9. Channel addresses are slot dependent. The steps in the procedures assumes that the option being tested is in slot 0. The channels for the various slots are specified as follows:

| Option Slot Number | Specify Channels |
|---|---|
| 0 | 0-09 |
| 1 | 10-19 |
| 2 | 20-29 |

2-4-10. The Multiplexer/Actuator Assembly must be reconfigured for some of the tests. In some cases, the option must be removed from the instrument so that jumpers can be moved, and then re-installed to complete the test. For example, in the first part of the first test, it is assumed that channels 0 and 1 are configured as actuators. This, however, only checks half of relays K0 and K1. To check the other half, the Multiplexer/Actuator Assembly must be removed from the instrument, four jumpers moved to different locations, and re-installed. If this is the case, the assembly must be reconfigured to the original configuration after completing the tests.

2-4-11. The tests should be performed in the order given. As each test is performed, check and record the results on the appropriate test card. The test cards are located between the test procedures and the calibration procedures.

## 2-4-12. Channel Resistance Test

2-4-13. The following test has two parts to it. In the first part, channels 0 and 1 of the Multiplexer/Actuator Assembly are configured as actuators. In the second part, they are configured as multiplexers. If channels 0 and 1 are configured as multiplexers, it is suggested that you configure the channels as actuators and perform the first part of the test. Do this to minimize confusion. If any channel is outside the specified limits, clean the terminal block edge connector and fingers of the option board, before replacing a relay. The cleaning procedure is explained in Section II.

2-4-14. An external ohmmeter is used for the following checks. The reason is that the HP 3421A is calibrated in the 4-Wire Ohms function at the factory, but the tests requires a 2-wire ohms measurement. Rather than re-calibrate the Model 3421A, or obtain results that are out of the specified limits, an external ohmmeter is used.

**2-4-15. Recommended Equipment.** The following equipment is recommended to perform the test.

Digital Voltmeter (HP Model 3456A)
HP-85 Computer

**2-4-16. Channel Resistance Test Procedure.** Do the following:

a. Press the instrument front panel switch "OFF" and unplug the ac line cord.

b. Make sure that all sources of external power are removed form the terminal block edge connector. Then remove the strain relief and grey WARNING cover from the option to be tested.

c. Turn the instrument upside down and loosen the bottom six screws.

d. Hold the top cover in place and turn the instrument upright. Then lift up and remove the top cover.

e. If either slot 1 or slot 2 option is to be tested, continue with step f. If the slot 0 option is to be tested, you must remove any option occupying slot 1. To remove the slot 1 option, do the following:

1. Remove the strain relief and grey WARNING cover from slot 1.

2. If the slot 1 option is a Digital I/O option, unplug the ribbon cable from the option. If the slot 1 option is a Multiplexer/Actuator Assembly, unplug both the ribbon cable and voltmeter bus cable.

3. Remove the four screws holding the option in place, and then remove the option.

4. Leave the four hex standoffs for slot 0 option in place to make sure the option is properly grounded.

f. Move J8 on the option to be tested to the "OUT" position.

g. Make sure that all series jumpers are in place (i.e., JM30, 40, 50, 60, and 70, and JM0 and 10 for older assemblies), and that no resistors have been substituted. Otherwise, the option needs to be removed from the HP 3421A and jumpers installed in these locations.

h. Make sure no shunt elements (i.e., jumpers or resistors) are installed at locations for JM31, 41, 51, 61, 71, 81, or 91.

i. To do the first part of the test, make sure the option has channels 0 and 1 configured as actuators. If they are, continue with step j. If they are configured as multiplexers, move the flying lead jumpers from the "MUX" positions to the "ACT" position. On older Multiplexer/Actuator Assemblies that do not have the flying lead jumpers, do the following:

1. Press the instrument front panel to the "OFF" position.

2. Loosen the four screws or hex standoffs (dependent on the location of the option) and remove the option from the instrument.

3. Unsolder JM16 and resolder it in the JM19 location. Unsolder JM15 and resolder it in the JM18 location.

4. Unsolder JM06 and resolder it in the JM09 location. Unsolder JM05 and resolder it in the JM08 location.

5. Channels 0 and 1 are now configured as actuators.

6. Replace the option back in the instrument.

j. On the terminal block edge connector, short the HI and LO of channels 2 to 9 together (i.e., short H2 to L2, H3 to L3, etc.).

k. Connect H0 and H1 to COMMON HI on the terminal block. Connect L0 and L1 to COMMON LO.

l. Connect an external ohmmeter (like the HP 3456A in the 4-Wire Ohms function) to COMMON HI and COMMON LO on the terminal block edge connector. Keep the leads as short as possible.

m. Make sure nothing is connected to the HP 3421A's front panel terminals.

n. Connect the HP-85 I/O cables (either HP-IL or HP-IB) to the instrument.

o. Press the HP 3421A front panel switch "ON".

p. If the option to be tested is in slot 0, execute the following program. If the option is in slot 1, modify line 20 to: FOR I = 10 TO 19. If the option is in slot 2, modify line 20 to: FOR I = 20 TO 29.

```
 10 CLEAR
 20 FOR I=0 TO 9
 30 OUTPUT 901 ;"CLS" ;I
 40 DISP "RECORD RESISTANCE OF CHANNEL ";I
 50 DISP "IT SHOULD BE 1.4 OHMS OR LESS"
 60 DISP "PRESS "CONT" TO MEASURE THE NEXT CHANNEL"
 70 PAUSE
 80 OUTPUT 901 ;"OPN" ;I
 90 NEXT I
100 END
```

q. Check and record the reading of each channel on the test card.

r. Since channels 0 and 1 are configured as actuators, only ½ of relays K0 and K1 are checked. To check the other half, configure the channels as multiplexers by moving the flying lead jumpers from the "ACT" positions to the "MUX" position. On older Multiplexer/Actuator Assemblies that do not have the flying lead jumpers, do the following:

1. Press the instrument front panel to the"OFF" position.

2. Loosen the four screws or hex standoffs (dependent on the location of the option) and remove the option from the instrument.

3. Unsolder JM19 and resolder it in the JM16 location. Unsolder JM18 and resolder it in the JM15 location.

4. Unsolder JM09 and resolder it in the JM06 location. Unsolder JM08 and resolder it in the JM05 location.

5. Channels 0 and 1 are now configured as multiplexers.

6. Replace the option back in the instrument.

7. Press the HP 3421A front panel switch "ON".

s. Remove H0 and H1 from the COMMON HI terminal of the terminal block edge connector. Leave the ohmmeter connected.

t. Remove L0 and L1 from the COMMON LO terminal of the terminal block edge connector. Leave the ohmmeter connected.

u. Short H0 to L0 and H1 to L1 on the terminal block edge connector.

v. Close channel 0 by executing the following program line.

```
OUTPUT 901 ;"CLS0"
```

w. Using the external ohmmeter (connected across COMMON HI and COMMON LO), check and record the reading on the test card for multiplexer channel 0.

x. Open channel 0 and close channel 1 by executing the following program line.

```
OUTPUT 901 ;"OPN0"
OUTPUT 901 ;"CLS1"
```

y. Using the external ohmmeter, check and record the reading on the test card for multiplexer channel 1.

z. Regardless of how channels 0 and 1 will be used, leave them configured as multiplexers for the next test. Also leave all HI and LO of each channel shorted together (i.e., H0 shorted to L0, H1 shorted to L1, etc.).

aa. Disconnect the external ohmmeter.

### 2-4-17. Offset Voltage Test

2-4-18. This test should be performed after the channel resistance checks have been made. Before starting this test, make sure of the following:

a. All channels are configured as multiplexers.

b. The HI and LO of channels 0 to 9 on the terminal block edge connector are shorted together (i.e., short H0 to L0, H1 to L1, etc.).

c. No connections are made to the COMMON HI and COMMON LO on the connector.

d. The attenuator on channel 2 is bypassed (J8 in the out position).

e. J6 and J7 are in the 0 position. Place in the correct position, if wrong.

**2-4-19. Recommended Equipment.** The following equipment is recommended to perform the test.

HP-85 Computer

**2-4-20. Offset Voltage Test Procedure.** Do the following:

a. If the option to be tested is in slot 0, execute the following program. If the option is in slot 1, modify line 20 to: FOR I = 10 TO 19. If the option is in slot 2, modify line 20 to: FOR I = 20 TO 29.

```
10 CLEAR
20 FOR I=0 TO 9
30 OUTPUT 701 ;"DCV" ;I
40 ENTER 901 ;A
50 DISP "OFFSET VOLTAGE OF CHANNEL ";I;"IS";A
60 DISP "RECORD THIS OFFSET VOLTAGE AND CHANNEL"
70 DISP "IT SHOULD BE WITHIN ±3 MICROVOLTS (±.000003V)"
80 DISP "PRESS "CONT" TO CHECK THE NEXT CHANNEL"
90 PAUSE
100 CLEAR
110 NEXT I
120 END
```

b. Check and record the reading of each channel. If any voltage is outside the specified limits, clean the terminal block edge connector and the fingers of the option board before replacing a relay. The cleaning procedure is explained in Section II.

**2-4-21. Channel 2 Attenuator Test**

2-4-22. This test checks the accuracy of the attenuator (10:1 Voltage Divider) on channel 2.

**2-4-23. Recommended Equipment.** The following equipment is recommended to perform the test.

HP-85 Computer
Stable 10 Vdc Power Supply

**2-4-24. Attenuator Test Procedure.** Do the following:

a. Remove the short on the terminal block edge connector from channels 2 and 3.

b. Move J8 on the option board to be tested to the "IN" position.

c. Connect the external power supply to channel 3 on the terminal block edge connector.

d. Set the power supply output as close to 10Vdc as possible. Then take a reading on channel 3 by running the following program. Write down the displayed voltage for future reference.

```
10 OUTPUT 901 ;"DCV3"
20 ENTER 901 ;A
30 DISP A
40 END
```

e. Leave the power supply set to exactly the same voltage that was used in step d. Then connect the power supply to channel 2 on the terminal block edge connector.

f. Change line 10 in the program to OUTPUT 901 ;"DCV2" and then run the program again. The voltage displayed should be 1/10 ±1% of the voltage read in step d.

g. Check and record the reading on the test card.

h. Perform all the preceding tests on all installed Multiplexer/Actuator Assemblies.

## PERFORMANCE TEST CARD
## CHANNEL RESISTANCE TEST

Hewlett-Packard Model 44462A

Multiplexer/Actuator Assembly

Slot Location______________

Test Performed By__________________

Date ____________

| Channel | Limit | Reading | Test Pass | Test Fail |
|---|---|---|---|---|
| 0, 10, or 20 (configured as actuator) | 1.4Ω | ________ | ________ | ________ |
| 0, 10, or 20 (configured as multiplexer) | 1.4Ω | ________ | ________ | ________ |
| 1, 11, or 21 (configured as actuator) | 1.4Ω | ________ | ________ | ________ |
| 1, 11, or 21 (configured as multiplexer) | 1.4Ω | ________ | ________ | ________ |
| 2, 12, or 22 | 1.4Ω | ________ | ________ | ________ |
| 3, 13, or 23 | 1.4Ω | ________ | ________ | ________ |
| 4, 14, or 24 | 1.4Ω | ________ | ________ | ________ |
| 5, 15, or 25 | 1.4Ω | ________ | ________ | ________ |
| 6, 16, or 26 | 1.4Ω | ________ | ________ | ________ |
| 7, 17, or 27 | 1.4Ω | ________ | ________ | ________ |
| 8, 18, or 28 | 1.4Ω | ________ | ________ | ________ |
| 9, 19, or 29 | 1.4Ω | ________ | ________ | ________ |

## PERFORMANCE TEST CARD
## OFFSET VOLTAGE TEST

Hewlett-Packard Model 44462A

Multiplexer/Actuator Assembly

Slot Location__________

Test Performed By__________

Date __________

| Channel | High Limit | Reading | Low Limit | Test Pass | Test Fail |
|---|---|---|---|---|---|
| 0, 10, or 20 | +3μV | | −3μV | | |
| 1, 11, or 21 | +3μV | | −3μV | | |
| 2, 12, or 22 | +3μV | | −3μV | | |
| 3, 13, or 23 | +3μV | | −3μV | | |
| 4, 14, or 24 | +3μV | | −3μV | | |
| 5, 15, or 25 | +3μV | | −3μV | | |
| 6, 16, or 26 | +3μV | | −3μV | | |
| 7, 17, or 27 | +3μV | | −3μV | | |
| 8, 18, or 28 | +3μV | | −3μV | | |
| 9, 19, or 29 | +3μV | | −3μV | | |

## PERFORMANCE TEST CARD
## CHANNEL 2 ATTENUATOR TEST

Hewlett-Packard Model 44462A

Multiplexer/Actuator Assembly

Slot Location__________

Test Performed By__________

Date __________

Pass__________ Fail__________

### 2-4-25. Temperature Calibration

2-4-26. Temperature calibration must be performed at an ambient temperature that allows the reference junction on the Multiplexer/Actuator Assembly to be between 0°C and 69.99°C. Once the reference junction has been calibrated, the instrument should be operated at an ambient temperature within ±5°C of the temperature at which it was calibrated. Operating the instrument within this 10°C window should result in a temperature measurement accuracy of ±1°C for each °C. Decrease the accuracy by .005°C outside the range.

2-4-27. Each Multiplexer/Actuator Assembly has its own reference junction. Therefore, each assembly must be calibrated individually. The calibration should be performed after the top and rear covers are in place and there has been at least a one hour warm-up. Once a Multiplexer/Actuator Assembly is calibrated for a slot, it should be used in the slot in which it was calibrated. For example, do not calibrate two assemblies and then switch their slot locations. In addition, if a new assembly is added to the instrument, make sure it is calibrated in the slot where it will be used.

2-4-28. There are two temperature calibration procedures that can be used. One procedure uses the HP 3456A digital voltmeter and the other uses the HP 3421A internal voltmeter. The HP 3456A procedure is more convenient since the HP 3456A will automatically determine the calibration temperature. In the HP 3421A calibration procedure, the calibration temperature must be calculated by the controller using a formula given in the procedure.

2-4-29. It is recommended that the temperature calibration be performed with the HP 3421A in the same physical location position as it will be used. That is, if the Model 3421A is to be used in the vertical position, calibrate the temperature function in that position. Likewise, if the Model 3421A is to be used in the horizontal position, calculate in that position.

**NOTE**

*The calibration RAM portion of the self test will always fail if a Multiplexer Option occupies a slot that does not contain calibration constants for the temperature function.*

*The factory places 25.00°C calibration constants in RAM for all slots that are either empty or contain Digital I/O Assemblies. To ensure temperature measurement accuracy, the temperature function must be recalibrated for each field installed Multiplexer/Actuator Assembly.*

**2-4-30. Recommended Equipment.** The following equipment is recommended to calibrate the temperature function.

HP-85 Computer
Multiplexer/Actuator Assembly
Temperature Calibrator Board (HP Part Number 03421-66505)
HP 3456A Digital Voltmeter (for the HP 3456A procedure)

**NOTE**

*If there is more than one HP 44462A Multiplexer/Actuator Assembly in your instrument, you can simultaneously calibrate all the assemblies using one 03421-66505 Temperature Calibrator Board for each assembly instead of one board for all assemblies. If this is done, only a one hour warm-up is required for all the assemblies instead of a one hour warm-up for each individual assembly.*

**2-4-31. Temperature Calibration Procedure Using the HP 3456A.** To calibrate the temperature function using the HP 3456A, perform the following procedure. The semi-automated test and calibration procedures in paragraph 1-4-67 in Chapter I of this manual can be used instead of the following manual procedure, if the Model 3421A Calibration and Test Cartridge (HP Part Number 03421-10001 Rev. C or higher) is available. (Note: Only Rev. C or higher tape will operate with the Temperature Calibrator Board.)

a. Identify the slot(s) with the Multiplexer/Actuator Assembly to be calibrated (slots 0, 1, and/or 2).

**CAUTION**

*In this procedure you are directed to remove power from the HP 3421A. Always make sure the calibration enable switch (S501 segment #8) is in the up position before the Model 3421A front panel switch is pressed off or ac power is disconnected. Failure to do this could cause the calibration RAM constants to be altered requiring complete recalibration of the instrument.*

*If an HP-IL controller is used that has the "Auto Off" feature, such as is available with the HP-71B and HP-75C/D (i.e., the controller automatically turns off if not used for a certain amount of time and in turning off executes a loop power-down), make sure the controller does not turn off when connected to the HP 3421A with the calibration enable switch in the down position. If the controller turns off, the Model 3421A may unexpectedly go into the power down mode. This could also cause the calibration RAM constants to be altered requiring complete recalibration of the instrument.*

b. Make sure the rear panel calibration switch (S501 segment #8) is in the up position. Then press the HP 3421A front panel switch to the off position and unplug the instrument's power cord.

c. Remove the black rear panel strain relief bar on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.

d. Remove the grey "WARNING" safety cover(s) on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.

e. Loosen the two captive screws holding the terminal block(s) to the Multiplexer/Actuator Option board(s) and then remove the terminal block(s).

f. Plug the Temperature Calibrator Board(s) (HP P/N 03421-66505) onto the Multiplexer/Actuator Assembly (or Assemblies) to be calibrated. Make sure the component side of the calibrator board is in the up position when plugging it onto the Multiplexer/Actuator Assembly.

g. Reinstall the grey "WARNING" safety cover(s) that was/were removed in step d. This ensures a more stable temperature for calibration.

h. Plug the HP 3421A power cord into an ac outlet and press the front panel switch on.

i. Allow the HP 3421A to warm-up for at least one hour.

j. Connect the HP 3421A's ~~HI and LO Sense Terminals to its~~ HI and LO Input Terminals, respectively. Then connect the Model 3421A's HI and LO Input Terminals to the HP 3456A's HI and LO Input Terminals, respectively.

k. Place the rear panel calibration enable switch (S501 segment #8) in the down position.

l. Select channel 4 of the Multiplexer/Actuator Assembly to be calibrated by executing the following program line. Fill in the blank space with the appropriate channel number. If the Multiplexer/Actuator Assembly is in slot 0, send "CLS04". If it is in slot 1, send "CLS14". If it is in slot 2, send "CLS24".

OUTPUT 901 ; "CLS____"

m. Select the appropriate function, range, and channel by executing the following program line. Fill in the blank space with the appropriate channel number. If the Multiplexer/Actuator Assembly is in slot 0, send "REF4". If it is in slot 1, send "REF14". If it is in slot 2, send "REF24".

OUTPUT 901 ; "REF____"

n. If after sending the "REF____" command an error is detected (the HP 3421A front panel LCD error indicator is on), the error is most likely caused by an uncalibrated Multiplexer/Actuator Assembly. The error should disappear after completing the temperature calibration (step p).

o. Using the HP 3456A 2-wire ohms function and temperature math function in °C, measure and note the temperature of the thermistor on the Temperature Calibrator board. Press the following buttons on the HP 3456A to read the temperature.

2-WrΩ Function button
Auto Range button
Blue Math button on Keyboard
"6" (i.e.,THM °C) button on Keyboard

p. Execute the following program line, filling in the blank space with the HP 3456A temperature reading. The decimal point in the temperature reading is optional. However, the two leading 0's are necessary. For example, if the temperature reading is 27.95°C, send "C002795" or "C0027.95".

OUTPUT 901 ; "C____________"

**NOTE**

*Be sure to wait at least 10 seconds after executing the "C__________" command, before disturbing the equipment setup. This ensures that the instrument has enough time to average ten readings and that the calibration step has been completed properly.*

q. After calibration is completed, send "REF___" again and read the results to determine if any error occurred and to observe that the temperature is within the ambient temperature range (20°C to 30°C). If the temperature is out of the specified range, try the temperature calibration again. If an error is detected, go to paragraph 1-4-42 in Chapter I of the manual to determine what the error is. Once the error is determined, perform the appropriate action as suggested in the paragraph. To send "REF___" and read the temperature, execute the following program lines.

```
OUTPUT 901 ; "REF___"
ENTER 901 ; A
DISP A
```

r. Repeat this procedure for each slot with a Multiplexer/Actuator Assembly requiring calibration, making sure to identify the correct channel address in steps l, m, and q.

s. This completes the calibration procedure using the HP 3456A. Return the calibration enable switch (S501 segment #8) to the up position, unless you are going to perform another calibration procedure.

**2-4-32. Temperature Calibration Procedure Using the HP 3421A.** To calibrate the temperature function using the HP 3421A, perform the following procedure. The semi-automated test and calibration procedures in paragraph 1-4-67 in Chapter I of this manual can be used instead of the following manual procedure, if the HP 3421A Calibration and Test Cartridge (HP Part Number 03421-10001 Rev. C) is available. (Note: Only Rev. C or higher tape will operate correctly with the Temperature Calibrator Board.)

a. Identify the slot(s) with the Multiplexer/Actuator Assembly to be calibrated (slots 0, 1, and/or 2).

**CAUTION**

*In this procedure you are directed to remove power from the HP 3421A. Always make sure the calibration enable switch (S501 segment #8) is in the up position before the Model 3421A front panel switch is pressed off or ac power is disconnected. Failure to do this could cause the calibration RAM constants to be altered requiring complete recalibration of the instrument.*

**CAUTION**

*If an HP-IL controller is used that has the "Auto Off" feature, such as is available with the HP-71B and HP-75C/D (i.e., the controller automatically turns off if not used for a certain amount of time and in turning off executes a loop power-down), make sure the controller does not turn off when connected to the HP 3421A with the calibration enable switch in the down position. If the controller turns off, the Model 3421A may unexpectedly go into the power down mode. This could also cause the calibration RAM constants to be altered requiring complete recalibration of the instrument.*

b. Make sure the rear panel calibration switch (S501 segment #8) is in the up position. Then press the HP 3421A front panel switch to the off position and unplug the instrument's power cord.

c. Remove the black rear panel strain relief bar on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.

d. Remove the grey "WARNING" safety cover(s) on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.

e. Loosen the two captive screws holding the terminal block(s) to the Multiplexer/Actuator Option board(s) and then remove the terminal block(s).

f. Plug the Temperature Calibrator Board(s) (HP P/N 03421-66505) onto the Multiplexer/Actuator Assembly (or Assemblies) to be calibrated. Make sure the component side of the calibrator board is in the up position when plugging it onto the Multiplexer/Actuator Assembly.

g. Reinstall the grey "WARNING" safety cover(s) that was/were removed in step d. This ensures a more stable temperature for calibration.

h. Plug the HP 3421A power cord into an ac outlet and press the front panel switch on.

i. Allow the HP 3421A to warm-up for at least one hour.

j. Key in and execute the following program. The program, as written, is setup to measure the temperature of the Multiplexer/Actuator Assembly in slot 0. To measure the temperature of the assembly in slot 1, specify "TWO14" in line 40. To measure the temperature of the assembly in slot 2, specify "TWO24" in line 40.

```
10 A=1.285496378E-3
20 B=2.360998857E-4
30 C=9.324409398E-8
40 OUTPUT 901 ; "TWO4"
50 ENTER 901 ; R
60 D=1/(A+B*LOG(R)+C*LOG(R)  3)-273.16
70 D=INT(D*100+.5)/100
80 DISP "TEMPERATURE IN DEGREES CELSIUS:";D
90 END
```

k. The HP-85 should be displaying the temperature in °C.

l. Place the rear panel calibration enable switch (S501 segment #8) in the down position.

m. Select the appropriate function, range, and channel by executing the following program line. Fill in the blank space with the appropriate channel number. If the Multiplexer/Actuator Assembly is in slot 0, send "REF4". If it is in slot 1, send "REF14". If it is in slot 2, send "REF24".

```
OUTPUT 901 ; "REF____"
```

n. If after sending the "REF____" command an error is detected (the HP 3421A front panel LCD error indicator is on), the error is most likely caused by an uncalibrated Multiplexer/Actuator Assembly. The error should disappear after completing the temperature calibration (step o).

o. Execute the following program line, filling in the blank spaces with the temperature displayed on the HP-85 (step k). The decimal point in the temperature reading is optional. However, the two leading 0's are necessary. For example, if the temperature reading is 27.95°C, send "C002795" or "C0027.95".

```
OUTPUT 901 ; "C____________"
```

**NOTE**

*Be sure to wait at least 10 seconds after executing the "C____________" command, before disturbing the equipment setup. This ensures that the instrument has enough time to average ten readings and that the calibration step has been completed properly.*

p. After calibration is completed, send "REF____" again and read the results to determine if any error occurred and to observe that the temperature is within the ambient temperature range (20°C to 30°C). If the temperature is out of the specified range, try the temperature calibration again. If an error is detected, go to paragraph 1-4-42 in Chapter I of this manual to determine what the error is. Once the error is determined, perform the appropriate action as suggested in the paragraph. To send "REF____" and read the temperature, execute the following program lines.

```
OUTPUT 901 ; "REF____"
ENTER 901 ; A
DISP A
```

q. Repeat this procedure for each slot with a Multiplexer/Actuator Assembly requiring calibration, making sure to identify the correct channel address in steps j, m, and p.

r. This completes the calibration procedure using the HP 3421A. Return the calibration enable switch (S501 segment #8) to the up position, unless you are going to perform another calibration procedure.

# SECTION V
# ADJUSTMENTS

2-5-1. This section normally contains instrument adjustment procedures. Since the Model 44462A Multiplexer/Actuator Assembly has no adjustment procedures, there is no adjustment information in this section. There is, however, a temperature calibration procedure for the reference junction which is explained in Section IV of this chapter and also in Section IV of Chapter 1 (Mainframe Service Information).

# SECTION VI
# REPLACEABLE PARTS

2-6-1. This section normally contains information for ordering replaceable parts. However, the replaceable parts for the Model 44462A Multiplexer/Actuator Assembly are included in Chapter 1 (Mainframe Service Information), Section VI of the manual.

# SECTION VII
# MANUAL CHANGES

## 2-7-1. INTRODUCTION

2-7-2. This section has information to adapt this chapter to the first Multiplexer/Actuator Assemblies manufactured with HP Part Number 44462-66504 (the current assemblies have part number 44462-66514). This section also adapts the chapter to assemblies having no ERC (Engineering Revision Code) number or a number lower than shown on the title page. Refer to paragraph 2-7-3 for a short description of ERC numbers.

### 2-7-3. Engineering Revision Code (ERC)

2-7-4. The engineering revision code (ERC) is changed whenever a change is made to an assembly. The change could be a printed circuit board revision, a component value change, added or deleted component, a component part number change, or a revised test and assembly procedure. The ERC label is the only one on the printed circuit board that has a four digit number. ERCs were implemented on this instrument with the introduction of the 03421-66511 motherboard. The first ERC was 2334. Refer to Chapter 1 (Mainframe Service Information), Section I for more information on ERC numbers.

## 2-7-5. CHAPTER CHANGES

2-7-6. Most changes in this section apply to the schematics and component locators in Section VIII, and to the parts list (Table 1-6-4) in Chapter 1, Section VI of the manual. If there is only a minor change, like a component value change or a minor circuit change, modify the schematic and Table 1-6-4 presently in the manual. If a major change to a schematic is made, refer to the schematic and component locator in this section of the chapter, instead of Section VIII.

2-7-7. If the ERC number is not listed on the title page or in this section, refer to the supplied *MANUAL CHANGES* supplement for updating information. Also, if a *MANUAL CHANGES* supplement is supplied, make all indicated ERRATA changes to correct any errors in this chapter.

## CHANGE 1

### Description

This change applies to Multiplexer/Actuator Assemblies with HP Part Number 44462-66504. This number is for sale in the United States and Canada only. The change involves component reference designator numbering changes on the replaceable parts list, component locator, schematic, and other locations in this chapter.

**NOTE**

*The following reference designator changes are for the parts list, component locator, and schematic only. However, these reference designators may also appear at other locations in this chapter.*

### Table 1-6-4 (Replaceable Parts) and Figure 2-8-1 (Multiplexer/Actuator Assembly Schematic) Changes

Do the following changes in the table, schematic, and component locator.

| Change | | | | | | | |
|---|---|---|---|---|---|---|---|
| From | To | From | To | From | To | From | To |
| C1 | C01 | K0 | K00 | K4 | K40 | K8 | K80 |
| C2 | C02 | K1 | K10 | K5 | K50 | K9 | K90 |
| F1 | F01 | K2 | K20 | K6 | K60 | VR1 | VR01 |
| F2 | F02 | K3 | K30 | K7 | K70 | VR2 | VR10 |

## CHANGE 2

### Description

This change applies to Multiplexer/Actuator Assemblies that have no ERC number and to assemblies with an ERC number of 2334. It involves changing the Multiplexer/Actuator configuration jumpers from flying lead jumpers to soldered-in wire jumpers.

### Figure 2-8-1 (Multiplexer/Actuator Assembly Schematic) Changes

Change the component locator on the apron page of Figure 2-8-1 to the one shown in Figure 2-7-1 (shaded area shows changes).

Do the changes on the schematic in Figure 2-8-1 as shown in Figure 2-7-2 (shaded area shows changes).

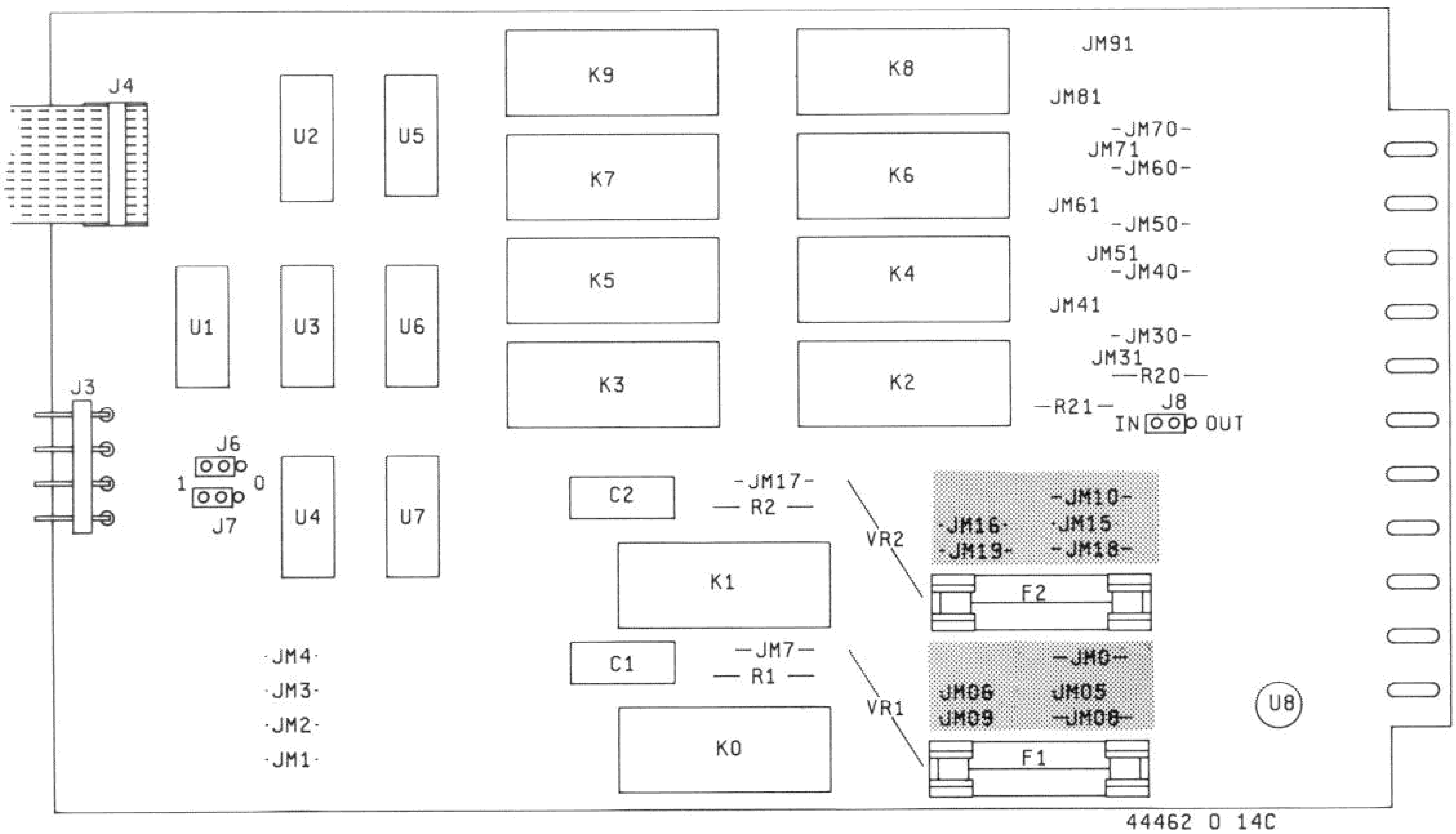
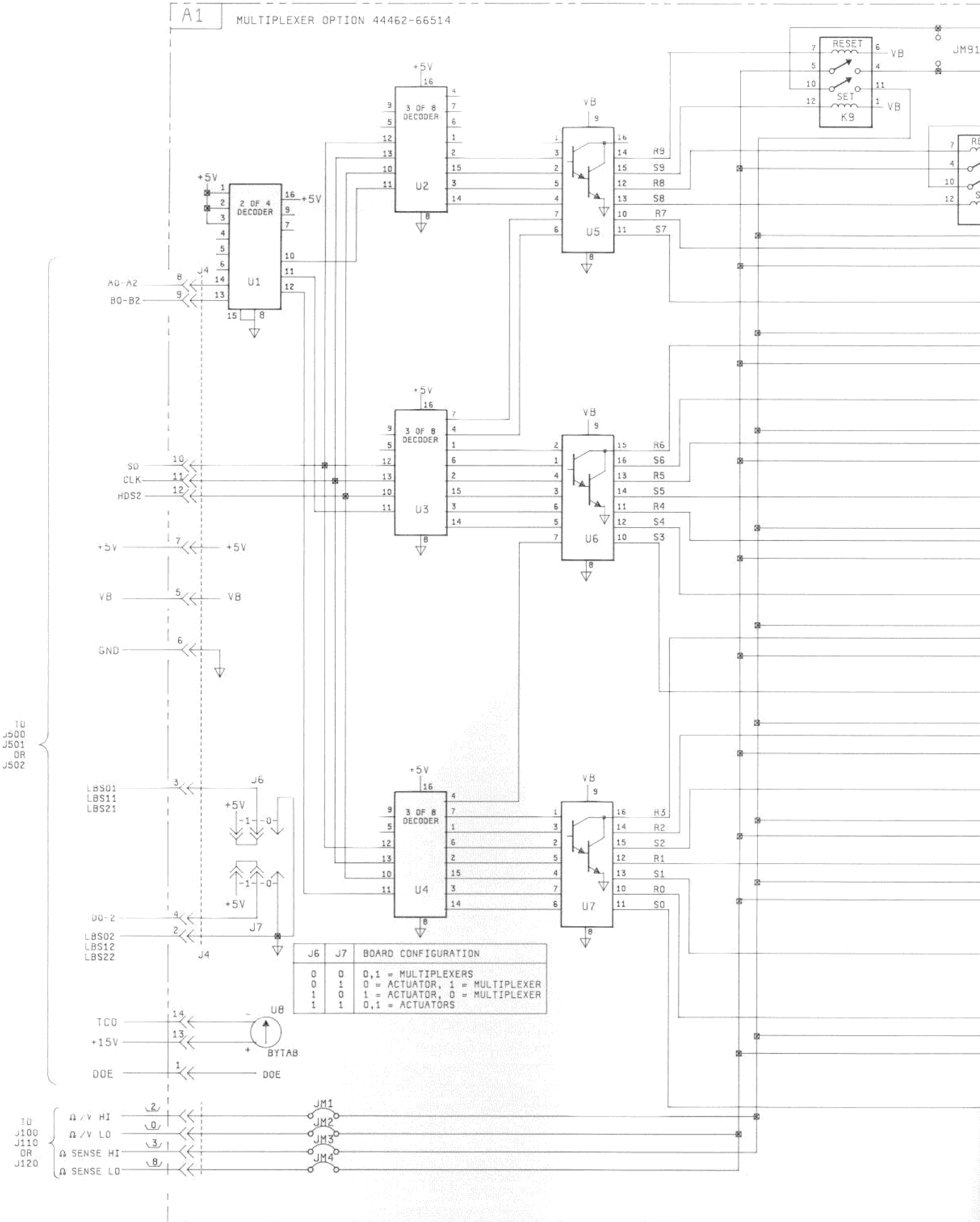



**Figure 2-7-1. Component Locator (Change 2)**

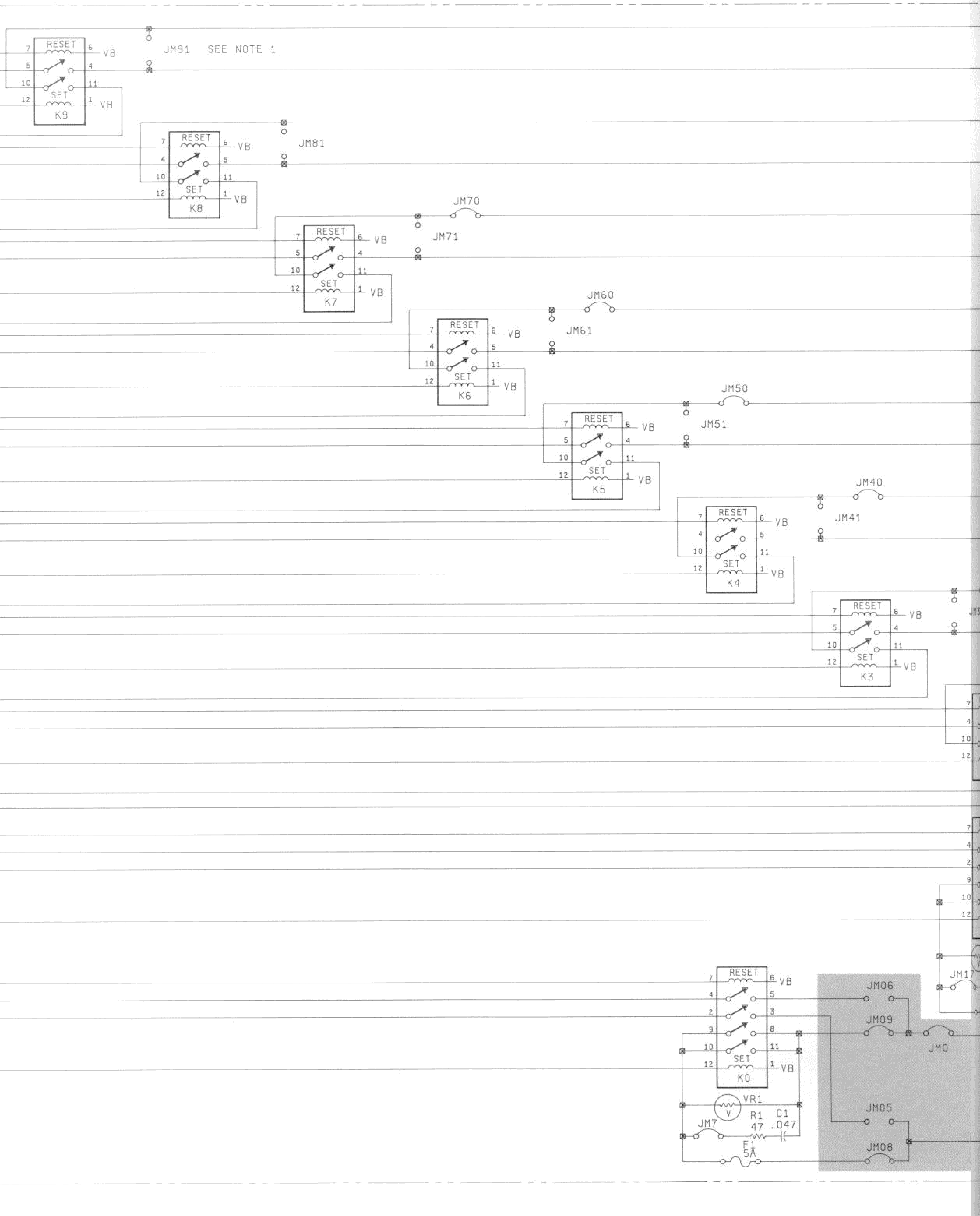
## IC Power Supply Configurations

| IC # | Type | HP P/N | VB | +5V | +15V | GND |
|---|---|---|---|---|---|---|
| U1 | MC14556BCP | 1820-1412 | — | 1,2,3<br>16 | — | 8,15 |
| U2-U4 | MC14028BCP | 1820-1962 | | 16 | — | 8 |
| U5-U7 | XSTR-ARY | 1858-0047 | 9 | — | — | 8 |
| U8 | AD590JH | 1826-0698 | — | — | BY TAB | — |




| J6 | J7 | BOARD CONFIGURATION |
|---|---|---|
| 0 | 0 | 0,1 = MULTIPLEXERS |
| 0 | 1 | 0 = ACTUATOR, 1 = MULTIPLEXER |
| 1 | 0 | 1 = ACTUATOR, 0 = MULTIPLEXER |
| 1 | 1 | 0,1 = ACTUATORS |

NOTE 1. JM05, 06, 15, 16, 31, 41, 51, 61, 71, 81 AND 91
ARE NOT LOADED AT THE FACTORY


JM91 SEE NOTE 1
RESET
SET
K9
VB
JM81
K8
JM70
JM71
K7
JM60
JM61
K6
JM50
JM51
K5
JM40
JM41
K4
K3
JM06
JM09
JM0
K0
VR1
R1
47
C1
.047
JM7
F1
5A
JM05
JM08
JM17

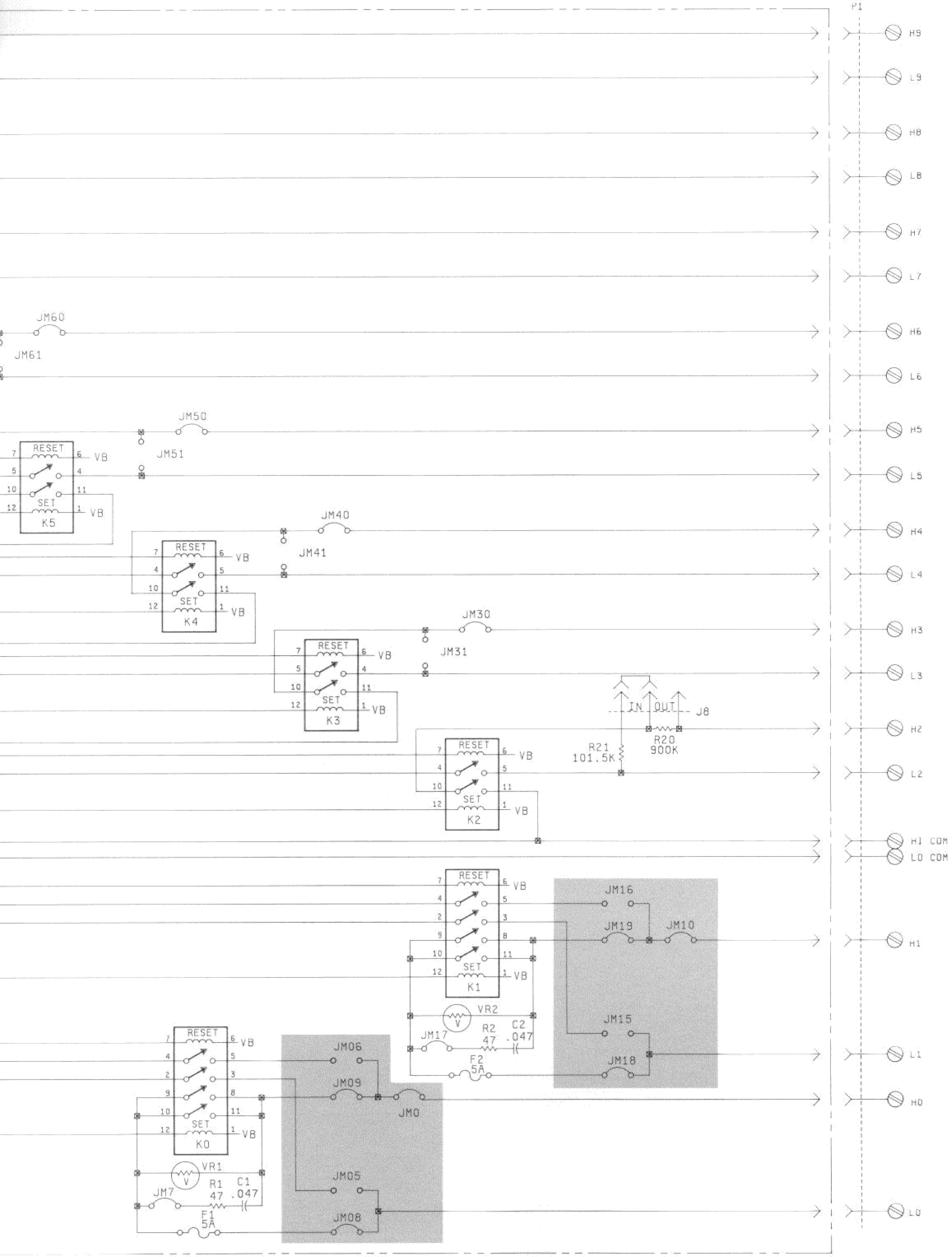



Figure 2-7-2. Schematic Changes (Change 2)

# SECTION VIII
# SERVICE

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 2-8-1. INTRODUCTION

2-8-2. This section contains the theory of operation and troubleshooting information of the Multiplexer/Actuator Assembly.

## 2-8-3. THEORY OF OPERATION

### 2-8-4. General

2-8-5. Each Multiplexer/Actuator Assembly has ten latching relays (K0 through K9) that are used as switches for the ten channels (channels 0 through 9). Channels 0 and 1 can be configured either as multiplexer or actuator channels. Channels 2 through 9 can only be configured as multiplexers. Channel 2 also has a built-in 1MΩ attenuator (i.e., 10:1 voltage divider) that is normally bypassed, but can be selected by moving J8 to the "IN" position.

2-8-6. Channels 2 through 7 have locations for both series and shunt elements. One use for a series /shunt element combination is a voltage divider. Channels 8 and 9 have locations for the addition of shunt elements only. Channels 0 and 1 have no provisions for either shunt or series elements.

2-8-7. The voltmeter bus consists of Ω/V HI, Ω/V LO, Ω SENSE HI, and Ω SENSE LO with each of these lines having a jumper (JM1-JM4) for isolation. Jumpers JM3 and JM4 have to be removed for all measurements, except 4-Wire Ohms.

### 2-8-8. Configuration of Channels 0 and 1

2-8-9. J6 and J7 are used by the mainframe to identify how channels 0 and 1 are configured (actuator or multiplexer). The configuration is explained in paragraph 2-2-29 in Section II of the chapter. If either channel has been identified as being configured one way, but is used the other way, an error will be generated. See Section II of this Chapter for more complete configuration information.

**NOTE**

*Early Multiplexer/Actuator Assemblies may have a J5 located next to J6. If the assembly has a J5, always keep in in the "0" position. If J5 is placed in the "1" position, the mainframe may not recognize that the assembly is installed or think it is a Digital I/O Assembly. This causes confusion when attempting to close a channel or make a measurement.*

### 2-8-10. Channel Addressing

2-8-11. The slot location occupied by a Multiplexer Assembly determines the channel addresses on that assembly. If the assembly is in slot 0, the channel addressses are 0 through 9. For slot 1, the channel addresses are 10 through 19, and for slot 2, they are 20 through 29.

### 2-8-12. Channel Address Decoding

2-8-13. U1 decodes its A and B inputs to select the appropriate 3 of 8 decoder. The selected 3 of 8 decoder uses the state of SD (Serial Data), CLK, and HDS2 (High Data Select) to determine which of its outputs to drive momentarily low. When the output goes low, it turns off a darlington amplifier in U5, U6 or U7. When the output returns high again, it turns on the darlington amplifier. This pulses the set or reset coil of the appropriate relay.

2-8-14. Suppose that a program line is executed to close channel 9 (e.g., OUTPUT 901 ; "CLS9"). First, U1 selects the correct 3 of 8 decoder, which in this instance is U2. To do this, its A and B inputs are decoded (A = 0, B = 1). This causes U1 pin 10 to go low which enables U2. U2 decodes SD ("0"), CLK ("1"), and HDS2 ("1"), and then drives its pin 15 output from high-to-low and back high again.

2-8-15. When U2 pin 15 pulses, the darlington amplifier in U5 that drives the set coil of K9 also pulses. This sets (closes) the K9 relay.

2-8-16. Now suppose a program line is executed to open channel 9 (e.g., OUTPUT 901 ; "OPN9"). All signal states are the same as they were when the channel was closed, except for HDS2 which is now a "0". This causes U2 pin 2 to pulse, which in turn resets (opens) K9.

2-8-17. Table 2-8-1 shows the various signal states that set and reset all channel relays.

**Table 2-8-1. Channel Decoding Truth Table**

| B | A | SD | CLK | HDS2 | Function |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | Reset K0 |
| 0 | 0 | 0 | 0 | 1 | Set K0 |
| 0 | 0 | 0 | 1 | 0 | Reset K1 |
| 0 | 0 | 0 | 1 | 1 | Set K1 |
| 0 | 0 | 1 | 0 | 0 | Reset K2 |
| 0 | 0 | 1 | 0 | 1 | Set K2 |
| 0 | 0 | 1 | 1 | 0 | Reset K3 |
| 0 | 0 | 1 | 1 | 1 | Set K3 |
| 0 | 1 | 0 | 0 | 0 | Reset K4 |
| 0 | 1 | 0 | 0 | 1 | Set K4 |
| 0 | 1 | 0 | 1 | 0 | Reset K5 |
| 0 | 1 | 0 | 1 | 1 | Set K5 |
| 0 | 1 | 1 | 0 | 0 | Reset K6 |
| 0 | 1 | 1 | 0 | 1 | Set K6 |
| 0 | 1 | 1 | 1 | 0 | Reset K7 |
| 0 | 1 | 1 | 1 | 1 | Set K7 |
| 1 | 0 | 0 | 0 | 0 | Reset K8 |
| 1 | 0 | 0 | 0 | 1 | Set K8 |
| 1 | 0 | 0 | 1 | 0 | Reset K9 |
| 1 | 0 | 0 | 1 | 1 | Set K9 |

### 2-8-18. Reference Junction

2-8-19. U8 is a temperature dependent current source that is used to make temperature measurements using thermocouples. Because U8 is temperature sensitive, and because each slot in the instrument may have a slightly different temperature, each slot is calibrated for temperature individually. Another reason for this is because U8 may have slightly different characteristics from one device to the next. By individually calibrating the temperature function for each slot, temperature accuracy is maintained.

### 2-8-20. Relay Protection

2-8-21. The varistors used by channels 0 and 1 protect the relay contacts from excessive loads when these channels are configured as actuators. The RC network provides relay contact protection against arcing, especially when an inductive load is switched.

### 2-8-22. TROUBLESHOOTING

2-8-23. Troubleshooting procedures are given for the following failures:

Unable to close one or more channels (channels 0 through 9)
Unable to close an actuator channel (channels 0 and 1 only)
Erroneous readings on multiplexer channels
Unable to take readings using internal voltmeter

NOTE

*In the procedures, it is assumed that the Interface Select Code is "9" and the device address is "01" (i.e., "901"). This is typical when using a HP-IL interface and the instrument is the first device in the loop. The procedures can also be used with HP-IB if the proper interface select code and device address are specified (e.g., "709" in place of "901").*

2-8-24. Channel addresses are slot dependent. The steps in the procedures assume that the option being checked is in slot 0. The channels for the various slots are specified as follows:

| Slot Number of Option | Specify Channels |
|---|---|
| 0 | 0-9 |
| 1 | 10-19 |
| 2 | 20-29 |

IMPORTANT

*If a Multiplexer Assembly is removed while troubleshooting, make sure it is re-installed in the slot from which it was removed.*

### 2-8-25. Recommended Equipment

2-8-26. The test equipment used in the following troubleshooting procedures is listed in Table 2-8-2.

**Table 2-8-2. Recommended Test Equipment**

| Instrument | Recommended Model |
|---|---|
| Digital Voltmeter | HP 3456A |
| Computer | HP-85 equipped with HP-IL or HP-IB Interface and I/O ROM |
| Oscilloscope | HP 1741A |
| DC Power Supply | |

### 2-8-27. Pre-troubleshooting Checks

2-8-28. Before troubleshooting a suspected problem on the Multiplexer Assembly, make the following power supply checks.

| Power Supply | Check At | Reading |
|---|---|---|
| VB | U5 pin 9 | +5.8V - +7.6V |
| +5 | U2 pin 16 | +5V ± .25V |
| +15V | U8 Tab | +15V ± .4V |

2-8-29. If any supply is too low, some device on the Multiplexer Assembly or on the mainframe is probably drawing excessive current, or the supply itself is bad. To find out if the problem is on the Multiplexer Assembly, unplug the ribbon cable from the Multiplexer Assembly and check the supplies on the ribbon cable connector as follows:

| Power Supply | Check At | Reading |
|---|---|---|
| VB | Ribbon Cable Connector Pin 5 | +5.8V - +7.6V |
| +5 | Ribbon Cable Connector Pin 7 | +5V ± .25V |
| +15V | Ribbon Cable Connector Pin 13 | +15V ± .4V |

2-8-30. If the power supply is defective when the ribbon cable is unplugged from the Multiplexer Assembly, first check the ribbon cable and ribbon cable connectors for continuity. If they are OK, refer to Chapter 1 (mainframe) for troubleshooting. If the power supply is good when the ribbon cable is unplugged, do the following:

a. Plug the ribbon cable back onto the Multiplexer Assembly.

b. Use a high resolution digital voltmeter (like the HP 3456A) and probe all pins on the ICs connected to that supply. The IC drawing excessive current will have the lowest voltage at its power supply connection. You can also connect one input of the voltmeter to the power supply and probe the pins of the IC with the other input. In this case, the largest voltage determines which pin is shorted.

### 2-8-31. Unable to Close One or More Channels (Channels 0-9)

2-8-32. This problem can be caused by the ribbon cable, channel decoding logic on the Multiplexer Assembly, or the mainframe. If the problem will not allow any channel (or group of channels) to be closed, suspect the ribbon cable, or the ribbon cable connectors. If these appear to be OK, check the channel decoding logic using the following procedure.

2-8-33. The procedure checks the channel decoding logic, and can be used to check all channels. This includes channels 0 and 1, regardless of how they are configured.

2-8-34. This procedure uses channel 9 as an example. It is the same for all channels, except that you must refer to the schematic for the correct IC and pin number associated with the channel being checked. The IC and pin numbers should be obvious. Also, the signal lines have different states, depending upon which channel is closed. This was outlined in Table 2-8-1.

2-8-35. Using channel 9 as an example, do the following:

a. Execute the following program. Modify the channel specifier as required.

```
10 OUPUT 901 ; "CLS9"
20 GOTO 10
30 END
```

b. Use an oscilloscope set to a sweep time of 10 ms and monitor U1 pin 10 for a TTL negative going 10 ms pulse. If channel 8 is being checked, make the same check at the same location. If the defective channel is 4, 5, 6, or 7, check for the negative going pulse at U1 pin 11. For channel 0, 1, 2, or 3, check for the negative going pulse at U1 pin 12. If the negative going pulse is OK, proceed with step c. If it is wrong, do the following:

1. Monitor U1 pin 13 (signal B) for a TTL high and U1 pin 14 (signal A) for a TTL negative going 10 ms pulse. These signal states will vary depending upon which channel is selected (see Table 2-8-1).

2. If these signals are OK, replace U1. If either is incorrect, unplug the ribbon cable from the Multiplexer Assembly and monitor pin 9 of the ribbon cable connector (signal B) for a steady TTL high, and pin 8 (signal A) for a TTL negative going 10 ms pulse. As in step b.1., these signal states will vary depending upon which channel is selected (see Table 2-8-1).

3. If the signals on the ribbon cable connector are correct, suspect the J4 socket, although the problem could be U1. If the signals are still bad, the problem could be the ribbon cable. Check the ribbon cable continuity.

4. If the ribbon cable is OK, the problem is on the mainframe.

c. Monitor U2 pin 15 for TTL positive going pulses, having a pulse width of about 10 ms. Modify the location to check this pulse depending upon which channel is closed. For example, if you are closing channel 8, check the signal at U2 pin 14; if you are closing channel 7, check the signal at U3 pin 4, etc.. If these pulses are occurring, then the SD, CLK, and HDS2 lines are probably OK, in which case you should proceed with step d. If these pulses are not occurring, do the following:

1. Check signal line SD at U2 pin 12 to make sure it is making transitions. SD can be checked at this location regardless of which channel is closed. If SD is making transitions, perform step 2. If SD is not making transitions, suspect the ribbon cable, ribbon cable connectors, or the mainframe.

2. Check signal line CLK at U2 pin 13 to make sure it is making transitions. CLK can be checked at this location regardless of which channel is closed. This signal has a narrow pulse width, but can be viewed with a 10 ms sweep time. If CLK is making transitions, it is probably OK, in which case you should perform step 3. If CLK is not making transitions, suspect the ribbon cable, ribbon cable connectors, or the mainframe.

3. Check signal line HDS2 at U2 pin 10 to make sure it is making transitions. HDS2 can be checked at this location regardless of which channel is closed. If HDS2 is making transitions, it is probably OK. If HDS2 is not making transitions, suspect the ribbon cable, ribbon cable connectors, or the mainframe.

4. If SD, CLK, and HDS2 all checked OK, the 3 of 8 decoder associated with the channel closure being attempted is bad (U2, U3, or U4).

d. Check the relay set line (S9) at U5 pin 15 for negative going pulses with pulse widths of about 10 ms. Modify where to check the signal depending upon which channel is being specified. For example, if channel 8 is specified, check the signal at U5 pin 13; if channel 7 is specified, check U5 pin 11; if channel 7 is specified, check U6 pin 16, etc.. The high level of this signal should go to VB. The low level should be about 1V. If the signal is OK but the channel will not close, the relay associated with that channel is defective. If the signal is not OK, driver U5, U6, or U7 is bad (depending upon which channel is selected).

### 2-8-36. Erroneous Readings on Multiplexer Channels (0-9)

2-8-37. This problem could be caused by a defective relay, the terminal block edge connector not making good contact with the edge connector fingers, or a bad trace. If the problem shows up on a channel with a series and/or shunt element installed, check that device(s) first. If the problem shows up on all channels, suspect the internal voltmeter, voltmeter bus cable, or the decoding logic.

2-8-38. The following procedure can be used to check all channels, including channels 0 and 1 if they are configured as multiplexers. The procedure uses channel 9 as an example. Modify the channel specifier as required.

a. Unplug the voltmeter bus cable from J3 on the Multiplexer Assembly being checked

b. Remove all external connections from a terminal block edge connector and then install it on the Multiplexer Assembly.

**NOTE**

*All channels, except 0, 1, 8, and 9, each provide a location for a series element. If the channel being checked has a series element installed (e.g., a resistor in the JM70 location on channel 7), use a short cliplead jumper and place a short across the series element.*

c. Close channel 9 by executing the following program line. Modify the channel specifier as required.

```
OUTPUT 901 ; "CLS9"
```

d. Use an external ohmmeter (like the HP 3456A) and measure the resistance between HI COM and H9 on the terminal block edge connector. This checks the high line of channel 9. To check the high line of channel 8, measure the resistance between HI COM and H8; for channel 7, measure the resistance between HI COM and H7, etc.. If the resistance is 1.4Ω or less, the high line of the channel is OK. If it is greater than 1.4Ω, make sure the terminal block edge connector is making good contact with the edge connector fingers, and the traces on the high line are OK. If the edge connector and traces are OK, and you are sure the decoding logic is operating properly (see paragraph 2-8-31), replace the relay.

e. Check the low line of the channel by measuring the resistance between LO COM and L9. To check channel 8, measure the resistance between LO COM and L8, etc.. If the resistance is 1.4Ω or less, the low line of the channel is OK. If it is greater than 1.4Ω, make sure the terminal block edge connector is making proper contact with the edge connector fingers, and the traces on the low line are OK. If the edge connector and traces are OK, and you are sure the decoding logic is operating properly (see paragraph 2-8-31), replace the relay.

f. Repeat this procedure for each channel to be checked.

g. Re-install the voltmeter bus cable.

### 2-8-39. Unable to Close and Actuator Channel (Channel 0 or 1)

2-8-40. Use the following procedure to check channel 0 or 1, if either is configured as an actuator.

a. Make sure J6 and J7 are in the position that reflect how channels 0 and 1 are configured. For example, if both channels are configured as actuators, J6 and J7 should both be in the "1" position.

**NOTE**

*Early Multiplexer/Actuator Assemblies may have a J5 located next to J6. If the assembly has a JM5, always keep in in the "0" position. If J5 is placed in the "1" position, the mainframe may not recognize that the assembly is installed or think it is a Digital I/O Assembly. This causes confusion when attempting to close a channel or make a measurement.*

b. Check and make sure the 5A fuse associated with the channel being checked is good.

c. Verify that all series elements that are installed on the high and low lines of the channels are good.

d. Close channel 1 by executing the following program line. If channel 0 is checked, modify the channel specifier to "CLS0".

```
OUTPUT 901 ; "CLS1"
```

e. Use an external ohmmeter (like the HP 3456A) and measure the resistance between H1 and L1 on the terminal block edge connector. If channel 0 is checked, measure the resistance between H0 and L0. If the resistance is 1.4Ω or less, the channel is good. If greater than 1.4Ω, make sure the terminal block edge connector is making good contact with the edge connector fingers. If it appears good and the address decoding logic is operating correctly, replace the relay.

### 2-8-41. Unable to Take Readings Using Internal Voltmeter

2-8-42. If this problem shows up on some channels (but not all channels), and you are sure the decoding logic is operating properly, check the channels individually (see paragraph 2-8-36). Use the following procedure if the problem shows up on all channels and you are sure the decoding logic is operating properly. The procedure uses channel 9 as an example. Modify the channel specifier as required.

a. If the channel has a series or shunt element installed, check those devices first.

b. If the channel has a shunt element installed, unsolder and lift one side of it.

c. If the channel has a series element installed, use a cliplead jumper and place a short across it.

d. Plug the terminal block edge connector onto the Multiplexer Assembly to be checked.

e. Connect the high lead of a DC Volt power supply to H9 on the terminal block edge connector. Connect the low lead to L9. Modify the connections to correspond to the channel being checked. For example, if channel 8 is being checked, connect the power supply high lead to H8 and the low lead to L8.

f. Take a reading by running the following program:

```
10 OUTPUT 901 ; "DCV9"
20 ENTER 901 ; A
30 DISP A
40 END
```

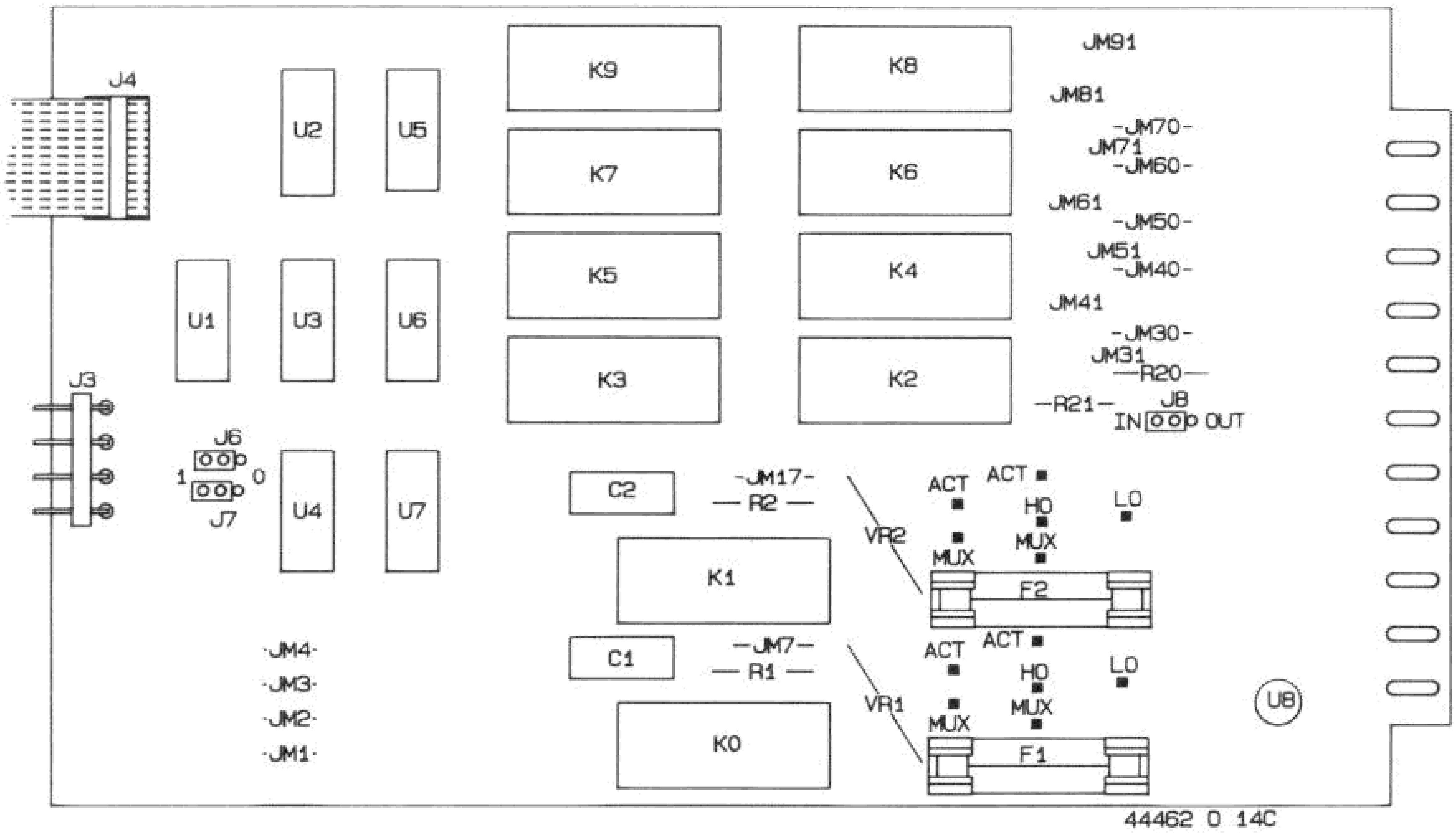
g. If the HP-85 is displaying the proper voltage, then the internal voltmeter is operating properly. If it is not displaying the proper voltage, do the following:

1. Use an external voltmeter and measure the voltage between JM1 and JM2. Reference the low lead of the voltmeter to JM2. If the voltage between JM1 and JM2 is 10V, proceed with step 2. If the voltage is wrong or non-existent, check the terminal block edge connector to make sure it is making good contact with the edge connector fingers. If the edge connector is OK, suspect a defective relay, although the decoding logic could be bad.

2. Check for 10V at J3, the voltmeter cable input connector. Red is associated with the high line and black is associated with the low line. If 10V appears at J3, proceed with step 3. If the voltage at J3 is wrong or non-existent, check for an open trace between JM1 and J3 and JM2 and J3.

3. Check each line of the voltmeter bus cable for continuity. Also, make sure the voltmeter bus cable is oriented properly when it is plugged onto the jacks on the motherboard and the Multiplexer Assembly. If the bus cable is OK and it is oriented properly, the problem is most likely the internal voltmeter.

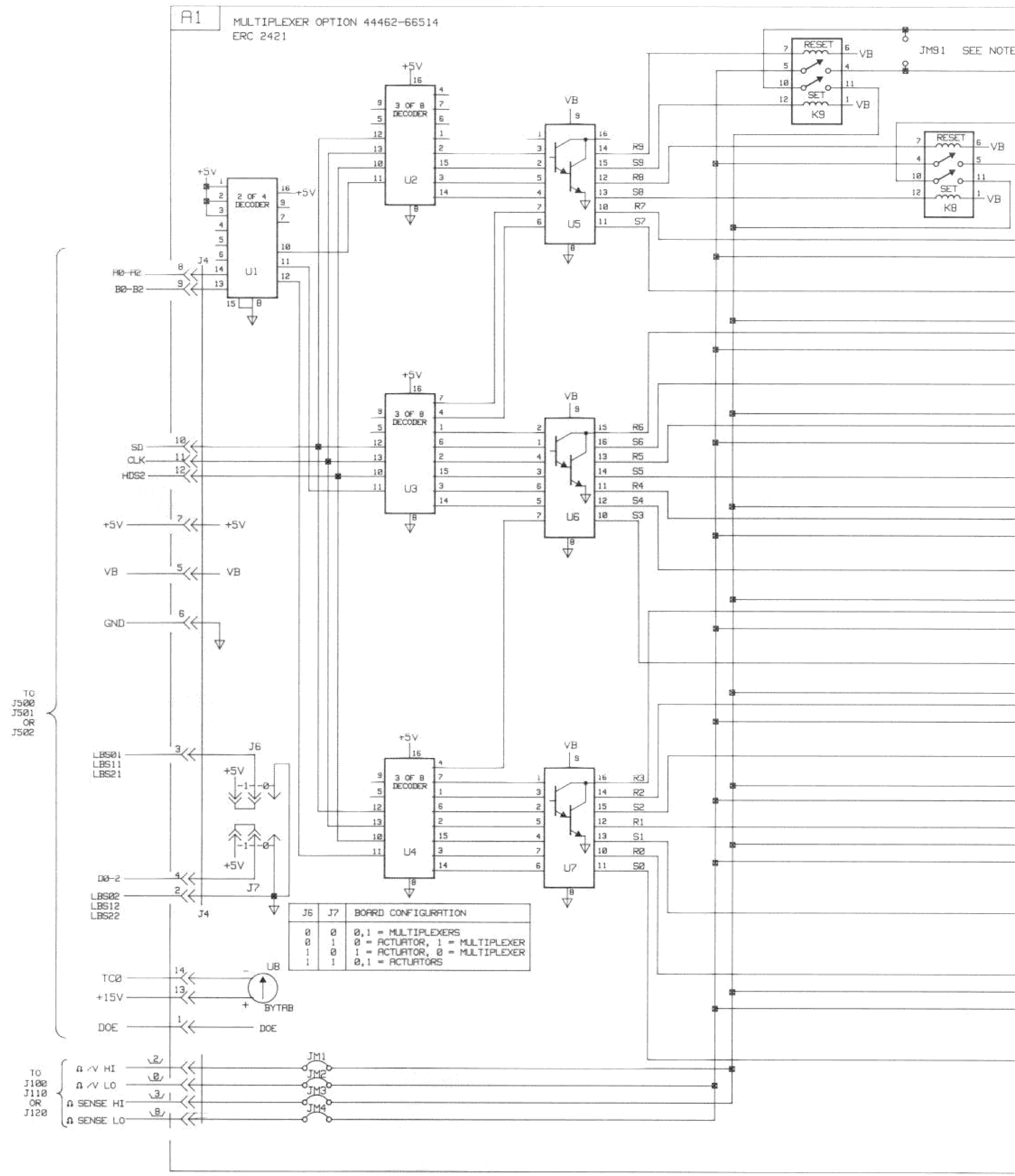
h. Reinstall the shunt element if it was removed.




HP PART NO 44462-66514

## IC Power Supply Configurations

| IC # | Type | HP P/N | VB | +5V | +15V | GND |
|---|---|---|---|---|---|---|
| U1 | MC14556BCP | 1820-1412 | — | 1,2,3<br>16 | — | 8,15 |
| U2-U4 | MC14028BCP | 1820-1962 | | 16 | — | 8 |
| U5-U7 | XSTR-ARY | 1858-0047 | 9 | — | — | 8 |
| U8 | AD590JH | 1826-0698 | — | — | BY TAB | — |




| J6 | J7 | BOARD CONFIGURATION |
|---|---|---|
| 0 | 0 | 0,1 = MULTIPLEXERS |
| 0 | 1 | 0 = ACTUATOR, 1 = MULTIPLEXER |
| 1 | 0 | 1 = ACTUATOR, 0 = MULTIPLEXER |
| 1 | 1 | 0,1 = ACTUATORS |

NOTE 1. JM 31, 41, 51, 61, 71, 81 AND 91
ARE NOT LOADED AT THE FACTORY

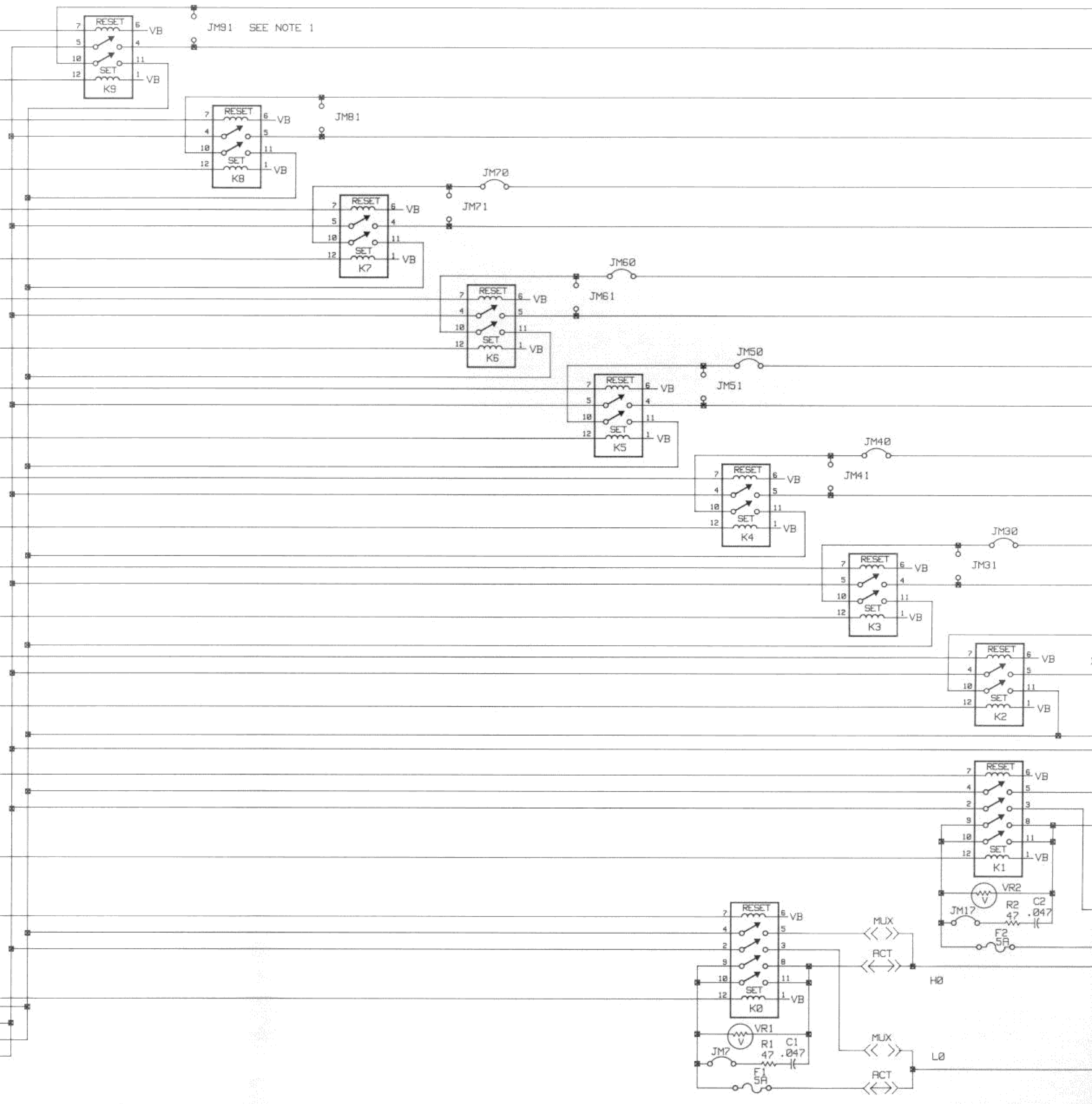



Figure 2-8-1. Mul

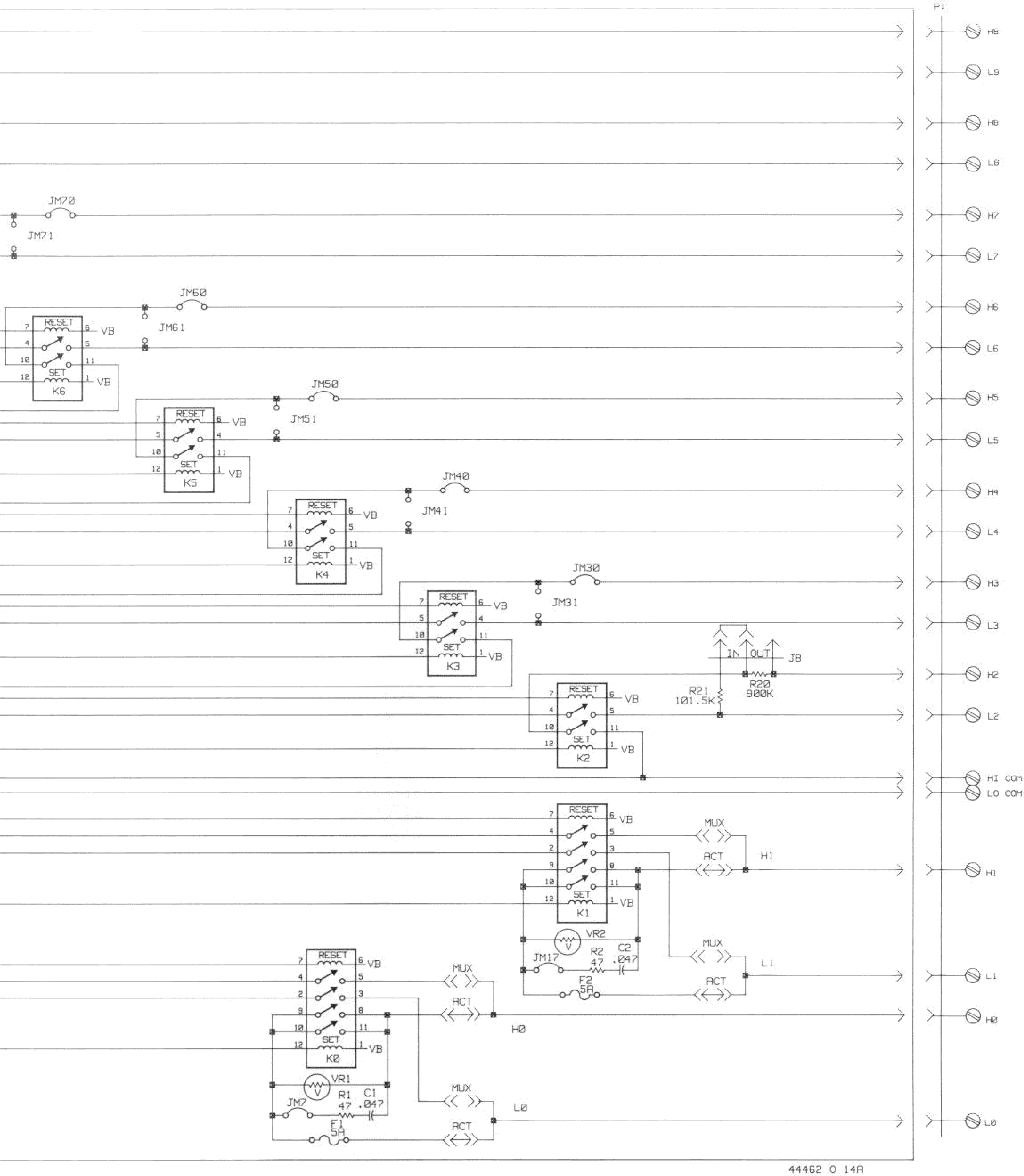



Figure 2-8-1. Multiplexer/Actuator Assembly Schematic

# CHAPTER 3
# MODEL 44465A
# (OPTION 050)
# DIGITAL I/O ASSEMBLY

# CHAPTER 3

# MODEL 44465A (OPTION 050) DIGITAL I/O ASSEMBLY

#### Engineering Revision Codes (ERCs)

This chapter applies directly to Digital I/O assemblies with an engineering revision code of 2334. See Section VII of this chapter if your assembly has an ERC lower than 2334. If the ERC of your assembly is above 2334, updating information may be on a yellow *MANUAL CHANGES* supplement (located at the front of the manual).

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## TABLE OF CONTENTS

### CHAPTER 3



### LIST OF TABLES



### LIST OF ILLUSTRATIONS

**Section V - Adjustments**
This section normally has the adjustment procedures. However, since the Digital I/O Assembly has no adjustments, no procedures will be in this section.

**Section VI - Replaceable Parts**
For ease in obtaining part numbers, all the replaceable parts for the Digital I/O Assembly are in Chapter 1 (Mainframe Service Information), Section VI of the manual. Ordering information, and all chassis and mechanical parts are also included.

**Section VII - Manual Changes**
This section contains information to update this chapter for use with Digital I/O Assemblies that have ERC numbers different than shown on the title page of this chapter. It also adapts this chapter to assemblies that are different than what is described in this chapter.

**Section VIII - Service**
This section contains troubleshooting information, theory of operation, and the schematic.

## 3-1-4. OPTION DESCRIPTION

3-1-5. The Digital I/O Assembly provides eight digital input channels and eight digital output channels. The inputs are typically used to monitor the state of limit and position switches. The outputs can be used as low voltage and current actuators.

## 3-1-6. PRINTED CIRCUIT BOARD IDENTIFICATION

3-1-7. The Digital I/O Board is identified by the board number and the engineering revision code. These two numbers identify the electrical characteristics of the circuit board. The engineering revision code and board part number are listed on the schematic, component locator, and replaceable parts list.

3-1-8. In any service related correspondence, identify the printed circuit board by using the board number followed by the engineering revision code. For example:

44465-66513-2334

would identify a Digital I/O option circuit board having an engineering revision code of 2334.

## 3-1-9. BOARD PART NUMBER AND ERC NUMBERS

3-1-10. The HP part number of the printed circuit board is etched on the pc board. It is a ten digit number, separated by a hyphen into two groups of five digits. The first five digits identify the model or assembly number; the last five digits are unique to the assembly.

3-1-11. The ERC number is on a label which is the only one on the pc board that has a four digit number. This four digit code is in the form of YYWW, where YY is the last two digits of the year minus 60, and WW is the week. For example, an ERC of 2334 would identify a change that was made to the assembly in the tenth week of 1983. Refer to Chapter 1, Section I for more information on ERC numbers.

## 3-1-12. SPECIFICATIONS

3-1-13. The Digital I/O Assembly specifications are listed in Table 3-1-1. These specifications are the performance standards or limits to which the assembly can be tested.

**Table 3-1-1. Digital I/O Assembly Specifications**

**OPTION 050**
**DIGITAL I/O ASSEMBLY**

**Isolated input specs:** 8 bits wide 0 - 7

**Input voltage levels:**

| | |
|---|---|
| Low voltage maximum | 0.8V |
| High voltage minimum | 2.0V |
| High voltage maximum (Hi-Lo) | 24.0V |
| High voltage maximum (between any terminal and earth ground) | ±42V |

**Maximum input current at low state:** 100 μA

**Minimum input current at high state:** 800 μA

**Maximum input current at high state (24V in):** 25mA

**Logic polarity:** Positive true

**Monitor mode (generates SRQ)**
Minimum pulse width: 1 mS in DO; 10 mS in DI
Trigger latch: high or low level
Masking: any combination of the 8 bits
Time from trigger to SRQ: 1 to 10 mS
Entire 8 bits latched when trigger received

**Isolated output specs:** 8 bits wide 0 - 7 VMOS FETS

| Input | Output Characteristics |
|---|---|
| Logic 1 | Low impedance <20Ω, sink <600 mA, 180 mW |
| Logic 0 | High impedance >10MΩ, 0 to +42V across switch (1 watt zener protection for inductive loads), or between any terminal and earth ground |

Each bit individually controlled

# SECTION II
# INSTALLATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 3-2-1. INTRODUCTION

3-2-2. This section contains information on how to install and remove the Digital I/O Assembly, and how to connect to external devices.

3-2-3. Always use clean handling techniques and anti-static procedures when removing, installing, and handling the option.

## 3-2-4. INITIAL INSPECTION

3-2-5. This option was carefully inspected and tested at the factory. If this option was ordered separately and needs to be installed in the HP 3421A, visually inspect it for physical damage that may have occured during transit. If there is any damage, promptly notify the nearest Hewlett-Packard Sales and Service Office. A listing of these offices is located at the end of this manual. If the shipping carton is damaged or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard Office, and keep the shipping materials for the carrier's inspection. The sales and service office will arrange for repair or replacement of your assembly (at HP's option) without waiting for the claim against the carrier to be settled.

## 3-2-6. GENERAL REMOVAL/INSTALLATION PROCEDURES

3-2-7. The following instructions shows how to remove and install the Digital I/O Assembly into the HP 3421A.

### 3-2-8. Option Removal Procedure

3-2-9. The following procedure first shows how to remove the instrument's top cover, and then how to remove the options in slots 1, 0, and 2. The top cover has to be removed first before any options can be removed. Also keep in mind that if you wish to remove the option in slot 0, remove the option in slot 1 first. Do the following:

NOTE

*If a HP 44462A Multiplexer/Actuator Assembly is removed from the instrument, make sure it is re-installed in the slots from which it was removed. If this is not done, the instrument must be re-calibrated for each Multiplexer whose slot location is different than the slot in which it was calibrated.*

**3-2-10. HP 3421A Top Cover Removal Procedure.** Do the following:

a. Make sure the ac power cord is disconnected from the instrument. Also make sure all external sources of power have been removed from the option terminal blocks.

b. Dependent on which options are to be removed, remove the appropriate strain relief and safety cover as follows:

1. Refer to Figure 3-2-1 and remove the two screws holding the black strain relief bar.

2. Loosen the two captive screw that hold the grey "WARNING" safety cover.

3. Loosen the two screws holding the terminal block to the option circuit board and then remove the terminal block.

c. Turn the instrument upside down. This is preferably done on top of a protective mat to reduce the possibility of scratching or marring the instrument case. Refer to Figure 3-2-2 and loosen the six screws on the instrument bottom.

d. Hold the top cover in place and turn the instrument upright. Then remove the top cover.

e. Refer to Figure 3-2-3 and locate the battery fuse toward the right rear of the instrument. Remove it from its socket. Instead of removing the fuse, you can unplug the red wire from the battery. If this is done, make sure the wire is placed out of the way and away from the battery.

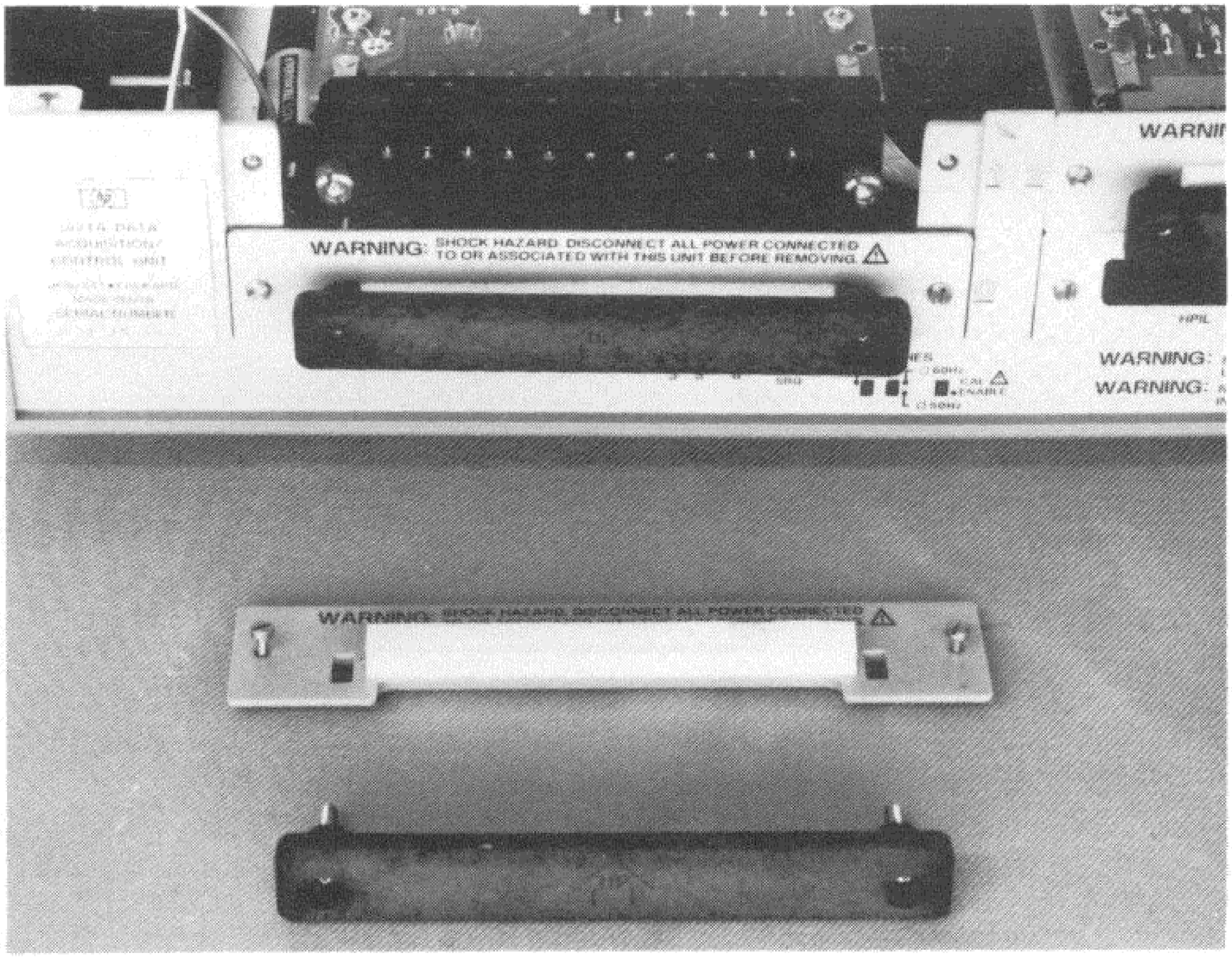


Figure 3-2-1. Remove Strain Relief and Safety Cover

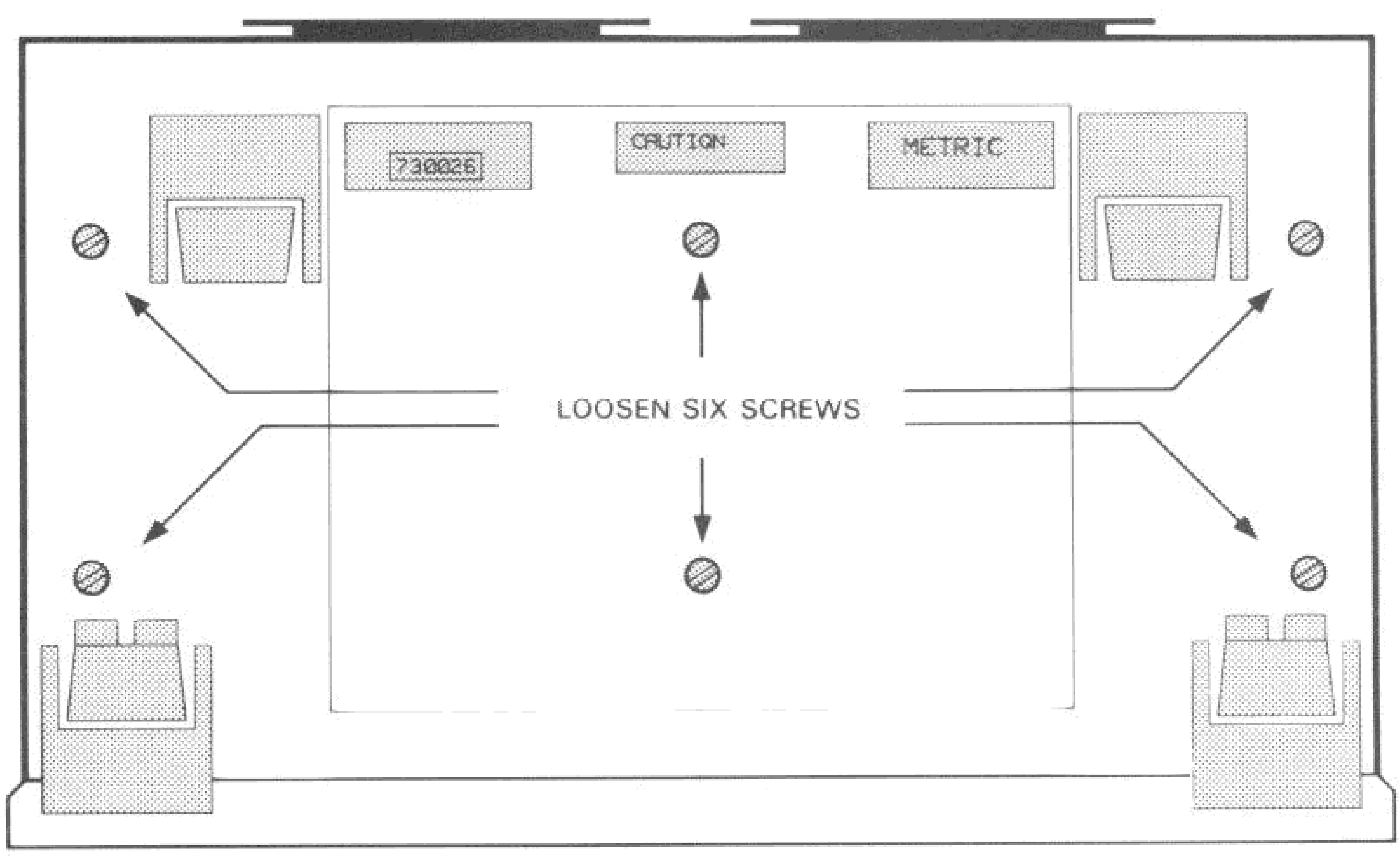



Figure 3-2-2. Loosen Bottom Screws

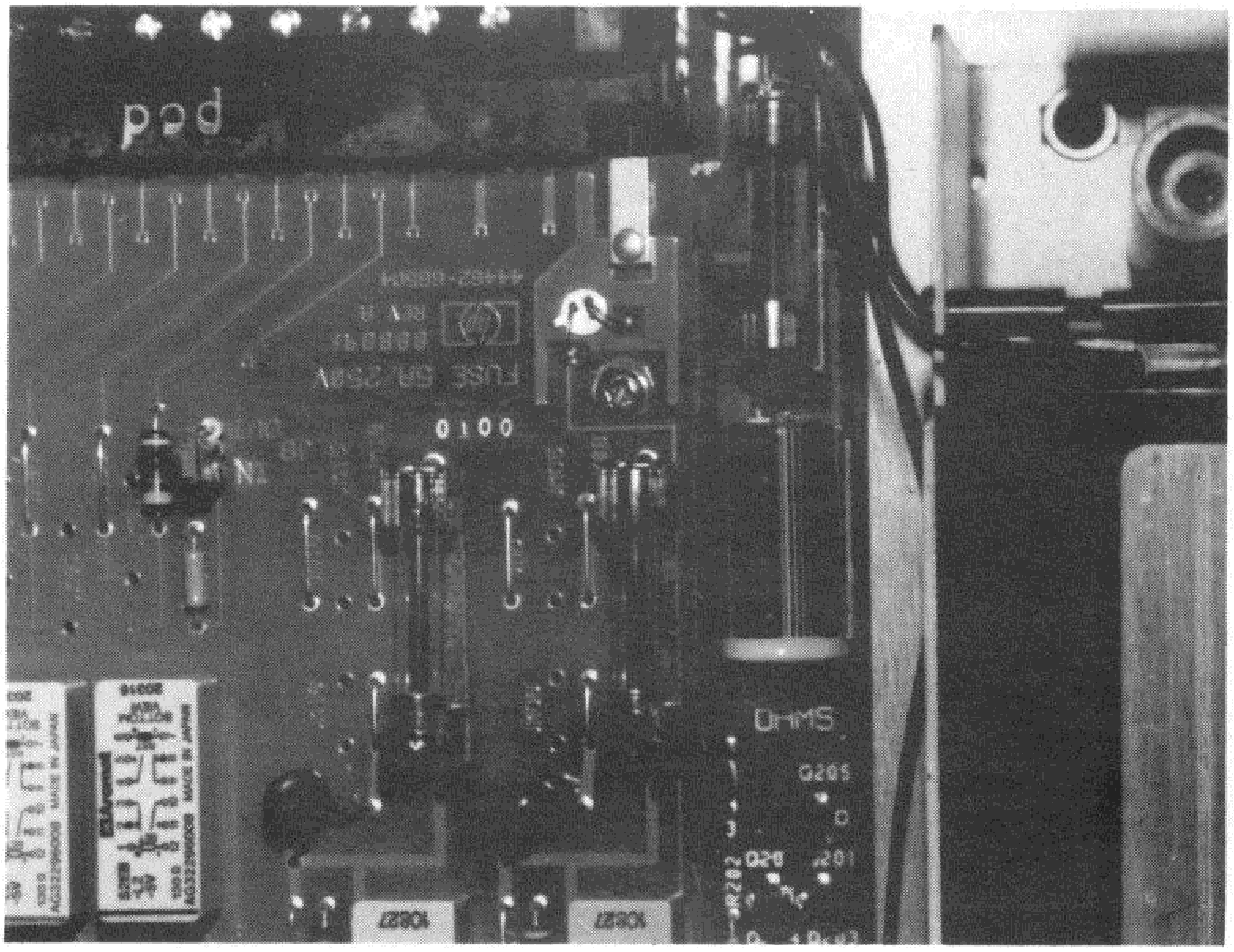


Figure 3-2-3. Remove Main Battery Fuse

**3-2-11. Slot 1 Option Removal Procedure.** Do the following:

a. Refer to Figure 3-2-4 and unplug the ribbon cable connector from the option in slot 1. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

b. Locate and remove the four screws holding the option in place.

c. Remove the option from slot 1. To prevent any recalibration of the option, tag the option as option 1 and make sure the same option board is placed back into the instrument into the same slot.

**3-2-12. Slot 0 Option Removal Procedure.** Make sure the option in slot 1 is removed, before removing the option in slot 0. Do the following:

a. Refer to Figure 3-2-4 and unplug the ribbon cable connector from the option in slot 0. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

b. Using a 7/32'' wrench, remove the four hex screws standoffs as shown in Figure 3-2-5.

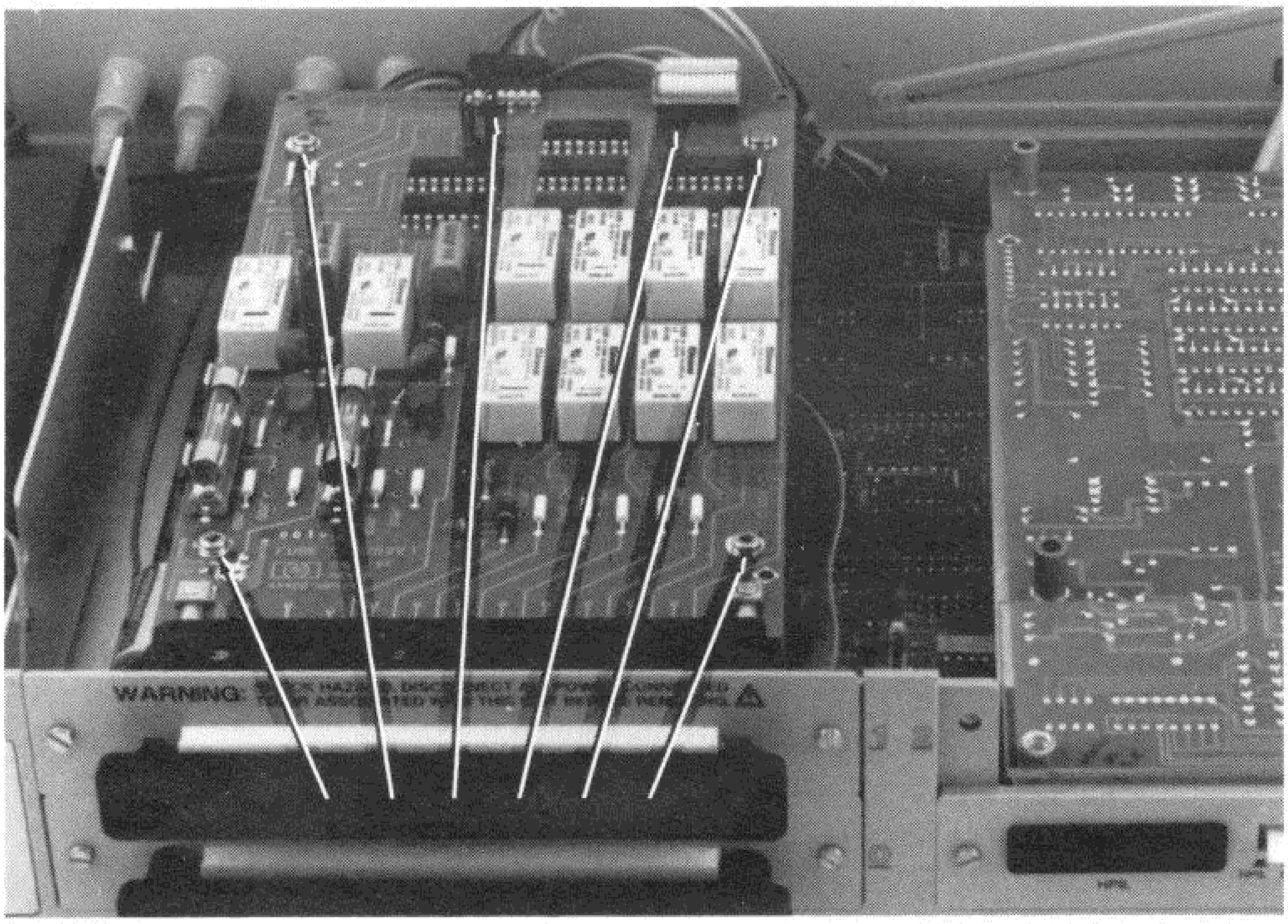



**Figure 3-2-4. Unplug Option Cable(s) and Remove Option Screws**

c. Remove the option from slot 0. To prevent any recalibration of the option, tag the option as option 0 and make sure the same option board is placed back into the instrument into the same slot.

d. Leave the bottom hex standoffs in place to secure the motherboard to the chassis.

**NOTE**

*The hex standoffs securing the motherboard to the chassis are shorter than the hex standoffs separating the slot 0 and slot 1 options.*

*Some of the first instruments manufactured may have round standoffs that are riveted to the motherboard instead of the screw-in hex standoffs. If the instrument has round standoffs, secure the motherboard to the chassis by using the four loose standoffs that were used to separate the slot 0 and slot 1 options and the four long screws. These must be in place to make the proper ground connection for the motherboard.*

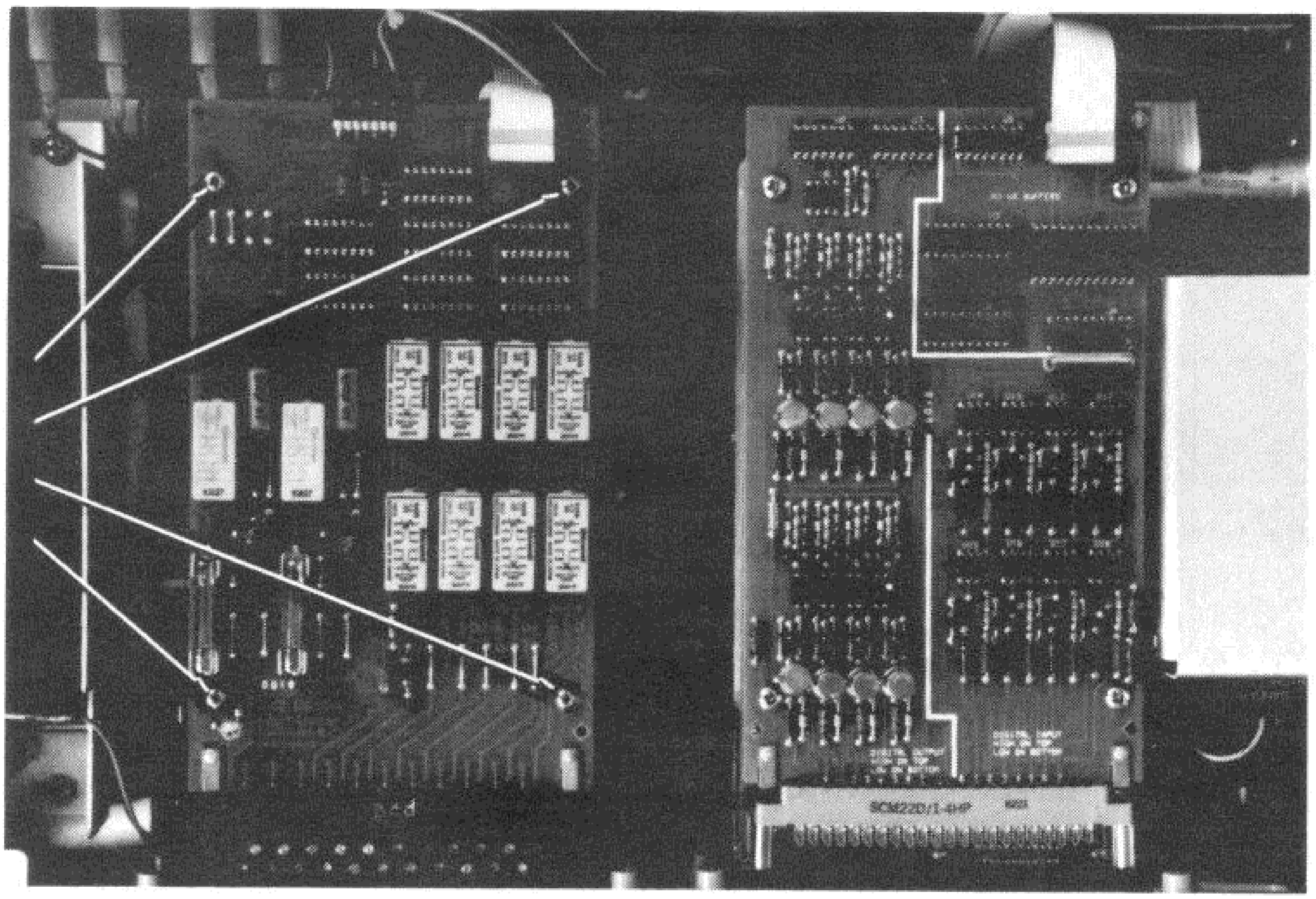


Figure 3-2-5. Removing Hex Screw Standoffs

**3-2-13. Slot 2 Option Removal Procedure.** If an option occupies slot 2, do the following:

a. Refer to Figure 3-2-4 and unplug the ribbon cable connector from the option in slot 2. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

b. Locate and remove the four screws holding the option in place.

c. Remove the option from slot 2. To prevent any recalibration of the option, tag the option as option 2 and make sure the same option board is placed back into the instrument into the same slot.

d. If an HP-IB or 12 Vdc Power Adapter Option is present, do not remove it. Leave all metal shields in place.

**3-2-14. Option Installation Procedure**

3-2-15. This procedure explains how to install the Digital I/O Assembly in the instrument. The procedure can be used to install a new assembly or re-install one previously removed.

3-2-16. When re-installing option assemblies, make sure all Multiplexer/Actuator Assemblies are returned to the same slot from which they were removed. If this is not done, the instrument should be recalibrated for the temperature function of each Multiplexer Assembly occupying a new slot. If a new assembly is being installed, remember to calibrate the temperature function for each slot.

3-2-17. When installing both Multiplexer/Actuator and Digital I/O Assemblies, it is recommended that Multiplexer Assemblies be installed in slots 0 and 1, and the Digital I/O Assemblies in slot 2. If there are three Multiplexer Assemblies, they can be installed in all three slots. That is, install Multiplexer Assemblies in slots 0 and 1, if there is a choice.

3-2-18. The following procedure shows how to install the options in slots 2, 0, and 1, and also how to install the top cover. Keep in mind that if you wish to install an option in slot 1, install the option in slot 0 first. Do the following:

**3-2-19. Slot 2 Option Installation Procedure.** Do the following:

a. If the HP 3421A has an HP-IB or 12 Vdc Power Adapter Option installed and it was not previously removed, place the slot 2 option on top of either the HP-IB or 12 Vdc Power Adapter Option. If the HP 3421A does not have either an HP-IB or 12 Vdc Power Adapter Option, place the slot 2 option directly on top of the bottom shield's standoffs. First, however, make sure the slot 2 option cable is routed as shown in Figure 3-2-6. The cable's red stripe should be oriented to the the right (pin 7 of the motherboard connector).

b. Set the slot 2 option in place with the component side up. Then put the four long screws in place. Do not tighten the screws at this time.

c. Plug the appropriate terminal block edge connector onto the slot 2 option.

d. Install the rear panel cover for the HP-IB or 12 Vdc Power Adapter Option (if applicable).

e. Install the rear panel cover (i.e., the grey "WARNING" cover) for the slot 2 option.

f. Secure the HP-IB connector (if applicable).

g. Align the slot 2 option so that the strain relief can be screwed into place. Screw the strain relief loosely into place.

h. Tighten the four screws that secure the slot 2 option. Do not overtighten the screws.

i. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 2. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 2 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J100 with the wires oriented as noted on the motherboard.

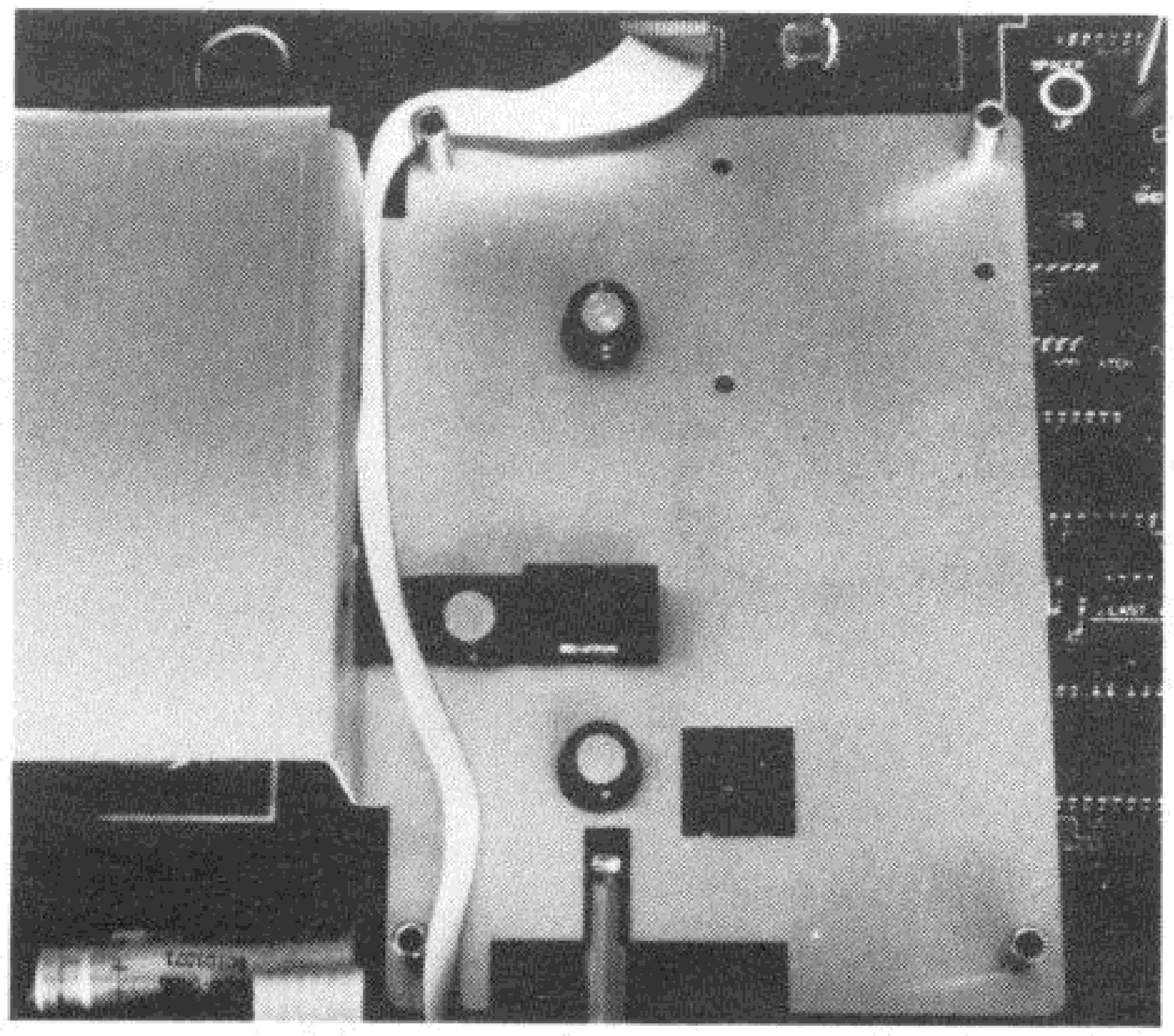


Figure 3-2-6. Slot 2 Option Cable Routing

**3-2-20. Slot 0 Option Installation Procedure.** This option should be installed before installing the slot 1 option. Do the following:

a. Before installing the slot 0 option, make sure the four motherboard hex standoffs are in place. Do not overtighten these standoffs. Excessive tourque (>11 in-lb) could break off the screw heads.

b. Route the ribbon cable for the slot 0 option as shown in Figure 3-2-7.

c. Set the slot 0 option in place, component side up. Make sure the cable underneath is not pinched. Loosely screw the remaining four hex standoffs in place. Do not tighten the four standoffs at this time.

d. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 0. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 0 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J110 with the wires oriented as noted on the motherboard.

e. Plug the appropriate terminal block edge connector onto the slot 0 option.

f. Replace the rear panel grey "WARNING" safety cover for the slot 0 option.

g. Align the terminal block edge connector with the rear panel holes and loosely attach the strain relief for slot 0.

h. Tighten the hex standoffs to secure the slot 0 option. Do not overtighten the standoffs.

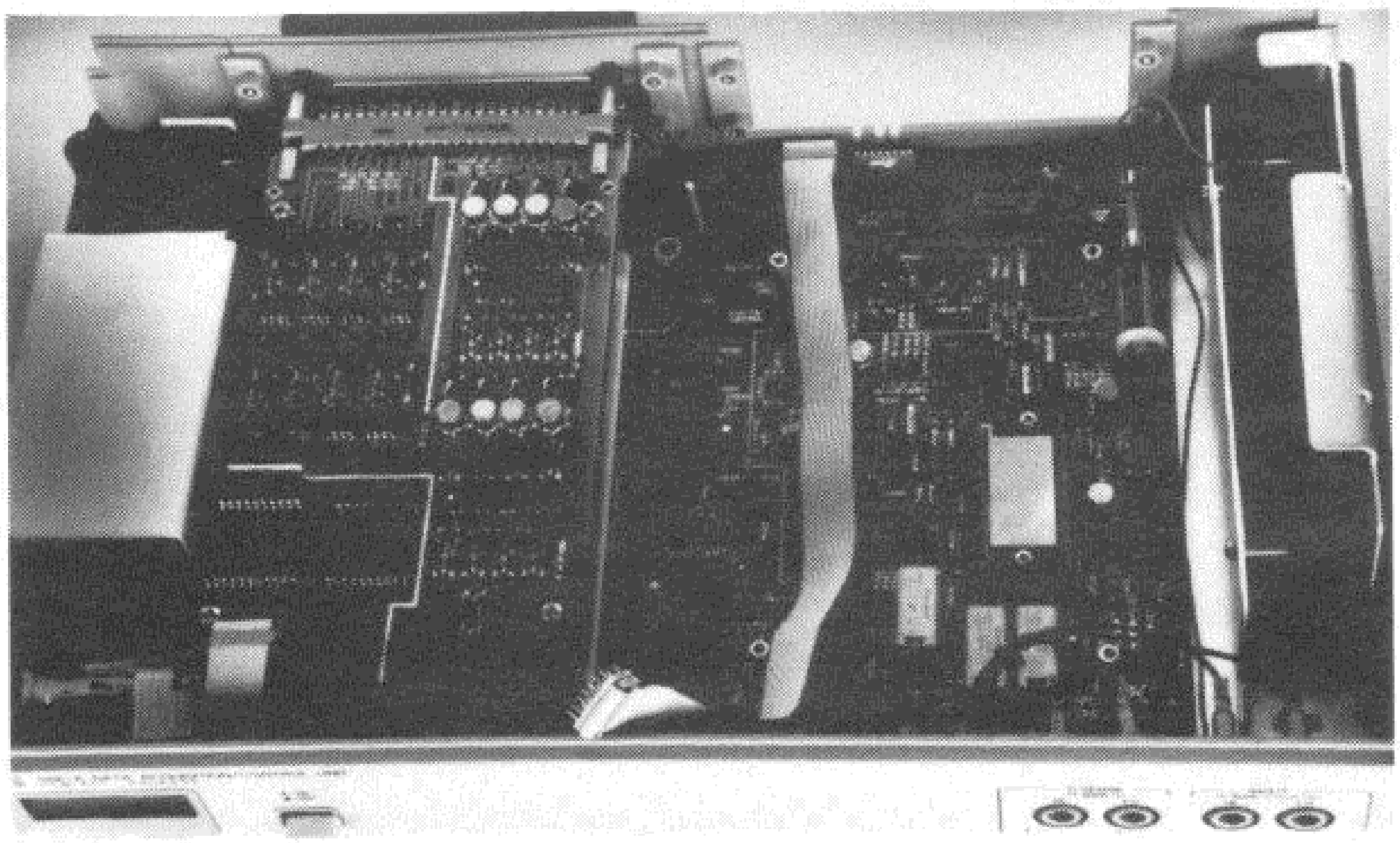


Figure 3-2-7. Slot 0 Option Cable Routing

**3-2-21. Slot 1 Option Installation Procedure.** Make sure there is a slot 0 option installed, before installing the slot 1 option. Do the following:

a. Route the ribbon cable from J501 on the motherboard across the slot 0 option as shown in Figure 3-2-8. Make sure the red stripe is oriented to the right (pin 7 of the motherboard connector).

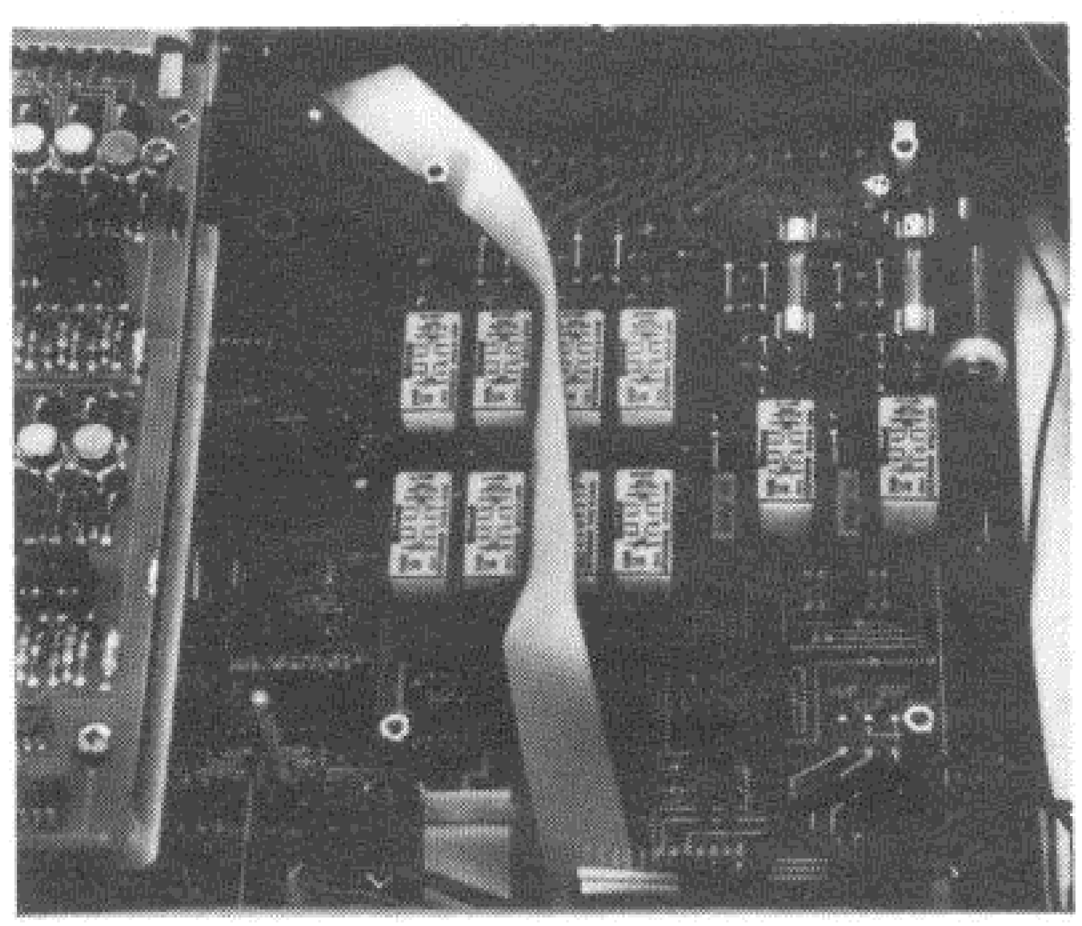


Figure 3-2-8. Slot 1 Option Cable Routing

b. Set the slot 1 option assembly in place. Make sure the ribbon cable underneath is not pinched. Then loosely screw four short screws in place. Do not tighten the four screws at this time.

c. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 1. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 1 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J120 with the wires oriented as noted on the motherboard.

d. Plug the appropriate terminal block edge connector onto the slot 1 option.

e. Replace the rear panel grey "WARNING" safety cover for the slot 1 option.

f. Align the terminal block edge connector with the rear panel holes and loosely attach the strain relief for slot 1.

g. Tighten the four screws to secure the slot 1 option. Do not overtighten the screws.

**3-2-22. HP 3421A Top Cover Installation Procedure.** Do the following

a. Before replacing the top cover, first make sure the main battery fuse has been replaced or the red wire to the battery has been reconnected. Then locate the six plastic spacers and place them on the cabinet screws as shown in Figure 3-2-9.

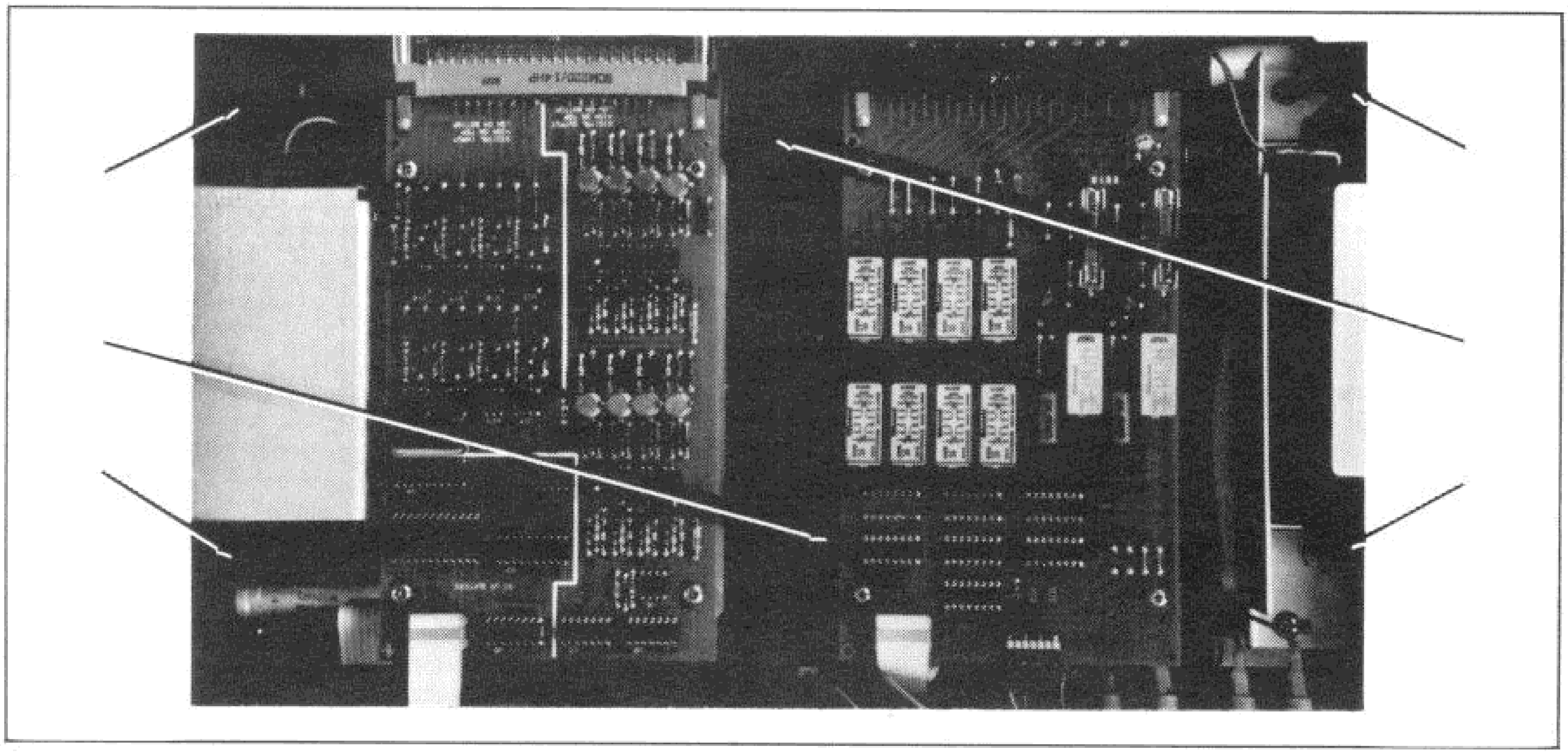


**Figure 3-2-9. Plastic Spacer Placement**

b. Set the instrument flat on your work bench. Make sure the bale handles on the front feet are collapsed.

c. Align the top cover and lower it in place. If the top cover does not go into place, make sure the front and rear grooves that guide it are properly aligned. If the grooves are aligned, one of the plastic spacers is probably out of alignment. To correct this, alternately move the top cover back and forth (left to right) until the spacers align properly.

d. Once the top cover is in place, hold the two halves of the case together and turn the instrument upside down. Tighten the six bottom screws.

### 3-2-23. STRAIN RELIEF

3-2-24. The black strain relief bar presses wires and cables connected to the terminal block edge connector against a piece of foam on the grey "WARNING" safety cover. This provides strain relief for cables and wires connected to option assemblies.

3-2-25. Figure 3-2-10 shows several wires coming from the terminal block of the slot 2 option. When installing the bar, loosely attach one end first. Hold the other end down and away from the instrument. Leave a small loop in the wires to avoid stress on the terminal block connections. This reduces the possibility of breaking the wires at the strain relief. Then rotate the bar up and connect the other end.

3-2-26. For wires smaller than 22AWG, it is recommended that these wires be bundled together starting at no more than 4" from the back of the instrument. This reduces the possibility of breaking the wires at the strain relief.

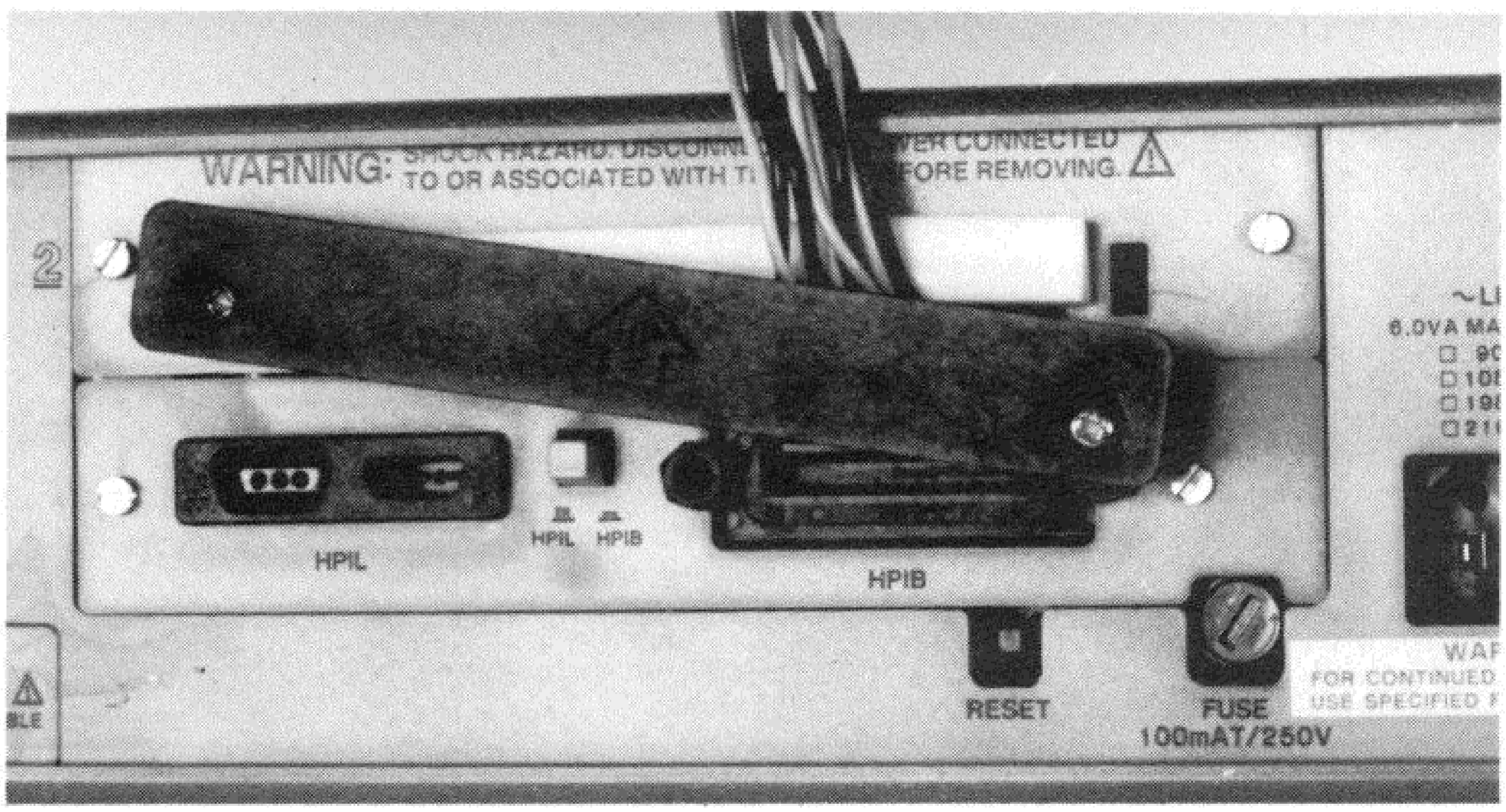



**Figure 3-2-10. Strain Relief for Slot 2**

### 3-2-27. TERMINAL BLOCK EDGE CONNECTOR

3-2-28. Wires to external devices must be soldered to the lugs of the terminal block. Before soldering to the lugs, make a good mechanical connection. NEVER use acid core solder. After the solder connections have been made, cover each joint with heat shrinkable tubing. This prevents adjacent wires from shorting to each other and helps serve as a strain relief.

3-2-29. Each Digital I/O Assembly has eight optoisolator inputs and eight transformer isolated outputs. The inputs can have levels ranging from TTL to 24V. The outputs can sink 300mA, but cannot exceed 0.6A.

3-2-30. The channel connection for the terminal block is shown in Figure 3-2-11. Extra terminal blocks are available by ordering HP Part Number 44466A.

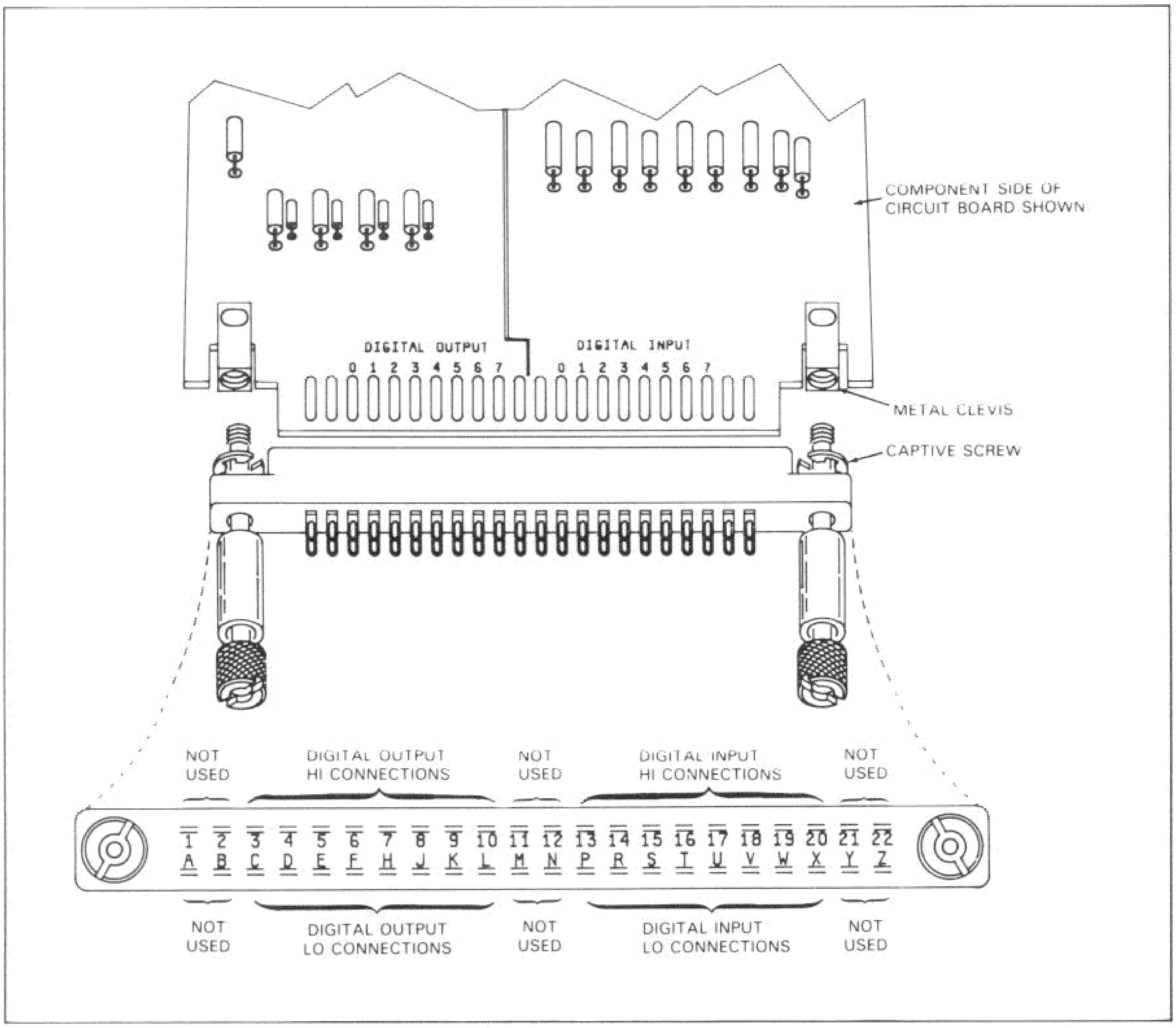



**Figure 3-2-11. Channel Connection Sequence for the Terminal Block Edge Connector**

# SECTION III
# OPERATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 3-3-1. INTRODUCTION

3-3-2. This section contains the operating information for the Digital I/O Assembly. This operating information is abbreviated, and is provided for the service trained individual, rather than an operator.

## 3-3-3. GENERAL INFORMATION

### 3-3-4. Power Requirements

3-3-5. The Digital I/O Assembly obtains its power from the mainframe via the ribbon cable connector that plugs into J4. On the mainframe, this ribbon cable plugs into either J500, J501, or J502, depending up which slot the Digital I/O Assembly occupies. The mainframe power supplies used include VB and +5V.

### 3-3-6. Information Transfers

3-3-7. When operating with HP-IL, most commands will "hold-up" the computer until all readings have been taken. For example, suppose you have two Multiplexer/Assembly and one Digital I/O Assembly installed and you program the instrument to take 20 readings (one reading from each multiplexer channel). With a reading rate of about two per second, 10 seconds are required to take all 20 readings. The computer cannot perform any task while the measurements are being taken.

3-3-8. With the HP-IB option installed, a switch on the HP-IB option enables and disables buffered transfers. This switch is factory preset to disable buffered transfers (switch up). In the up position, the HP-IB interface acts much the same as the HP-IL interface, holding up the computer until all measurements have been made. With the switch in the down position, buffered transfers are enabled. This releases the computer while the instrument is taking measurements. The buffered transfer mode provides the fastest transfer of information.

3-3-9. Commands that do not hold-up the computer are: digital monitor commands MN, MH, and ML; TOTalize function; and Digital Trigger (DT).

3-3-10. There are some other HP-IL and HP-IB characteristics that should be understood. When using HP-IL and a digital monitor mode (MN, MH, ML, or DT) is in effect, any communication through the interface will cause the mode to be aborted. For example, if the instrument is waiting for a Digital Trigger (DT) and the computer or some other instrument sends any commands or data through the interface, the instrument will abort the Digital Monitor mode. It must be reprogrammed for that mode before it will respond.

3-3-11. When the HP-IB option is installed and one of the Digital Monitor modes (MN, MH, ML, or DT) is configured, the instrument must be set to unlisten. This allows the instrument to interrupt the computer by pulling the SRQ line when the interrupt causing event occurs. For the HP-85, this is done by the following program line, assuming the interface is on select code 7.

```
SEND 7 ; UNL
```

### 3-3-12. Commands

3-3-13. Commands sent to the instrument instruct it to perform some specified task. At the end of this section is a list of commands that are used with the Digital I/O Assembly. Commands fall into two categories: standard and advanced.

a. Standard commands set up the instrument and then complete a measurement task. One command causes a complete measurement task to be performed.

b. Advanced Commands provide additional flexibility, but they do not perform a complete measurement task. These commands perform only one aspect of a measurement. Advanced commands are suitable for those who wish to tailor their system for some particular requirement.

### 3-3-14. BIT List Rules

3-3-15. The BIT list specifies the order in which digital channels are selected. The series of channels specified must follow these rules.

a. The default BIT list (asserted at power on or reset) consists of all digital channels in numerical sequence. The BIT list can be loaded with digital input bit numbers by the BIT command.

b. Channel addresses are separated by commas. However, a dash may be used to signify a contiguous set of channels. When using Advanced Commands, any command that specifies a channel must be separated from subsequent commands by either a colon (:) or a semicolon (;) but not a comma (,).

c. No more than 30 channels are accepted into the BIT list. Legal channel numbers are 00 through 27.

d. The mnemonic determines what type of channel can be loaded into the BIT list. In other words, if channel 1 is configured as an actuator channel, it should not be specified for any type of measurement (i.e., BIT1). If an attempt is made to load the channel list with an improper type of channel, a syntax error is generated and the command is aborted. If channels x-y are received and some channels in between and including x and y are the wrong type of channels for the command, they are not loaded into the list and the error message is not sent. The remainder of the channels are loaded into the list.

e. Leading zeros are ignored.

f. All syntax following a decimal point is ignored except for comma (,), dash (-), semicolon (;), colon (:), carriage return, or line feed.

g. Exponents are not allowed and cause a syntax error. The command is also aborted.

h. All lower case letters are interpreted as upper case. Blanks and the plus sign (+) are ignored. Commas and minus signs are used as channel number separators. The minus sign is also used to specify the lowest range and the shortest gate time. Colons and semicolons are used as terminators. All other punctuation cause a syntax error.

i. Terminators are required after any command (Standard or Advanced) that either specifies a channel or a decimal value, when that command is to be followed by another command. For example, the 'Mx' command is used to set the SRQ mask. This command can have a decimal integer value 'x' of between 0 and 255. Therefore, this command must be followed by a terminator if another command is to follow it. Example: OUTPUT 901 ; "M1;T0". Valid terminators are a colon (:), semicolon (;), carriage return or line feed.

## Digital I/O Assembly
## Command Guide

Commands fall into one of two categories: Standard or Advanced. Each Standard Command performs a complete measurement or function while two or more Advanced Commands are generally required to perform a measurement.

[] means optional bit list < > means mandatory bit list

**Standard Commands**

**CLS<x>** CLose Single channel 'x'. The instrument first identifies the type of channel at 'x' and then if 'x' is:

an Actuator - closes channel x possible actuator channel numbers re: 00,01,10,11,20,21).

a Digital Output Bit - closes it.

a Multiplexer - opens all multiplexer relays and closes channel 'x'.

**OPN[x]** Open channel(s). If channel 'x' is not sent, then the OPN command will open all channels digital outputs, actuators, and multiplexers. If 'x' is sent, the instrument identifies the channels 'x' is

an Actuator - opens it.

a Digital Output - clears bit 'x'

a Multiplexer - opens it. This includes channels closed by the UC command. If 'x' was closed as a pair (i.e., CLPx) then its pair will be opened also.

**REDi** REaDs the digital input byte from slot i and replies with a decimal number from 0 to 255. This decimal number represents the values of the bits that were set. Must be an integer value. No decimal points or extra digits allowed.

**WRTi,[ab]c** WRiTe the decimal value [ab]c to slot i. The value [ab]c ≤255. If a and/or b not received then the instrument assumes leading zeros. Must be an integer value. No decimal points or extra digits allowed.

**BIT<x>[,y, ...z]** Reads the digital input bits (up to 30 in the bit list) and sends +0.000E+0 if the bit is low or +1.000E+0if the bit is high. Invalid bit numbers are 08,09,18, 19,28, and 29. Also configures for 3-digit readings.

**Advanced Commands**

Trigger: DTa = Digital Trigger, does a T3 when digital input bit 'a' goes low.

AN[decimal value 0-255] ANd mask, used with MN command.

DC[slot number, decimal integer value 0-255] Digital Clear specified output bits.

DS[slot number, decimal integer value 0-255] Digital Set specified output bits.

LS<BIT list> Load Single channels into bit list.

M[decimal integer number] Set SRQ Mask.

MH<digital bit> Monitor digital input bit and SRQ interrupt when bit goes high. Exponents illegal; ignores everything after decimal point.

ML<digital bit> Monitor digital input bit and SRQ interrupt when bit goes low. Exponents illegal; ignores everything after decimal point.

MN<slot number> Monitor slot and compare to AN mask and XR mask. SRQ interrupt when result = 0. Must be integer value.

RS ReSet.

SR Read Status Registers

UC<channel number> Unconditionally Close specified channel.

XR[decimal integer value 0-255] eXclusive-oR mask, used with the MN command.

# SECTION IV
# OPERATION VERIFICATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 3-4-1. INTRODUCTION

3-4-2. This section contains the operational verification procedures for the Digital I/O Assembly. A Diagnostic Terminal Block (P/N 03421-66504) can be used to run verification tests on the HP 44465A Digital I/O Assembly. This is done using an HP-41C/CV Handheld Computer or an HP-85 Personal Computer. The HP-41C/CV must be equipped with the HP 44468A Data Acquisition Pac ROM to use the test fixture. To use the fixture using an HP-85, you must have the HP 3056DL software package or the HP 3421A Calibration and Test Tape Cartridge (P/N 03421-10001, Rev. C or above).

## 3-4-3. RECOMMENDED EQUIPMENT

3-4-4. The recommended test equipment to run the performance tests is listed in Table 3-4-1.

**Table 3-4-1. Recommended Equipment**

| Instrument | Recommended Model |
|---|---|
| 5V DC Power Supply | |
| Computer | HP-85 equipped with HP-IL or HP-IB and I/O ROM |
| 1 kΩ Resistor, 5%, 1/8W | |
| 4 Cliplead Jumpers | |

## 3-4-5. OPERATION TEST PROCEDURE

3-4-6. These tests check that all output channels can be closed and opened, and that a "0" and "1" can be recognized on all input channels.

3-4-7. The Digital I/O Assembly can be installed in either slot 0, slot 1, or slot 2 to run the tests. Since all of the configuration is performed on the terminal block edge connector, it will not be necessary to remove the assembly during the tests.

3-4-8. These procedures assume that the computer interface is set to select code "9" and the device address is "01" (i.e. "901"). This is typical when HP-IL is the interface being used and the instrument is the first device in the loop. These procedures can also be used with HP-IB if the proper interface select code and device address are specified (e.g., "709" in place of "901").

3-4-9. Channel (or bit) numbers are slot dependent. These procedures assume that the assembly is in slot 0. If you are checking an assembly that occupies slot 1 or slot 2, the OUTPUT statements in the programs will have to be modified accordingly (see Table 3-4-2). For example, to specify bit 0 on an assembly in slot 1, specify "10". Notice in Table 3-4-2 that bit numbers 8, 9, 18, 19, 28 and 29 are not listed. These are illegal addresses.

**Table 3-4-2. Bit Addresses**

| | Bit Address if card is in Slot # | | |
|---|---|---|---|
| Bit # | Slot 0 | Slot 1 | Slot 2 |
| 0 | 0 | 10 | 20 |
| 1 | 1 | 11 | 21 |
| 2 | 2 | 12 | 22 |
| 3 | 3 | 13 | 23 |
| 4 | 4 | 14 | 24 |
| 5 | 5 | 15 | 25 |
| 6 | 6 | 16 | 26 |
| 7 | 7 | 17 | 27 |

3-4-10. To run the operational test, do the following:

a. Press the instrument front panel switch "OFF" and unplug the ac line cord.

b. Make sure that all sources of external power are removed from the terminal block edge connector. Then remove the strain relief and grey WARNING safety cover from the option to be checked.

c. Remove the terminal block edge connector from the option to be checked. At this point, either unsolder and remove all external connections from the edge connector or use one that does not have any connections. Extra edge connectors are available by ordering option number 44466A.

d. Replace the unwired terminal block edge connector onto the assembly to be checked.

e. Refer to Figure 3-4-1 and use cliplead jumpers to configure the terminal block edge connector as follows:

Short lug 3 to lug 13
Short lug C to lug P

Connect the 1 kΩ resistor between lug 13 and the high (+) side of the supply
Connect lug P to the low (−) side of the supply

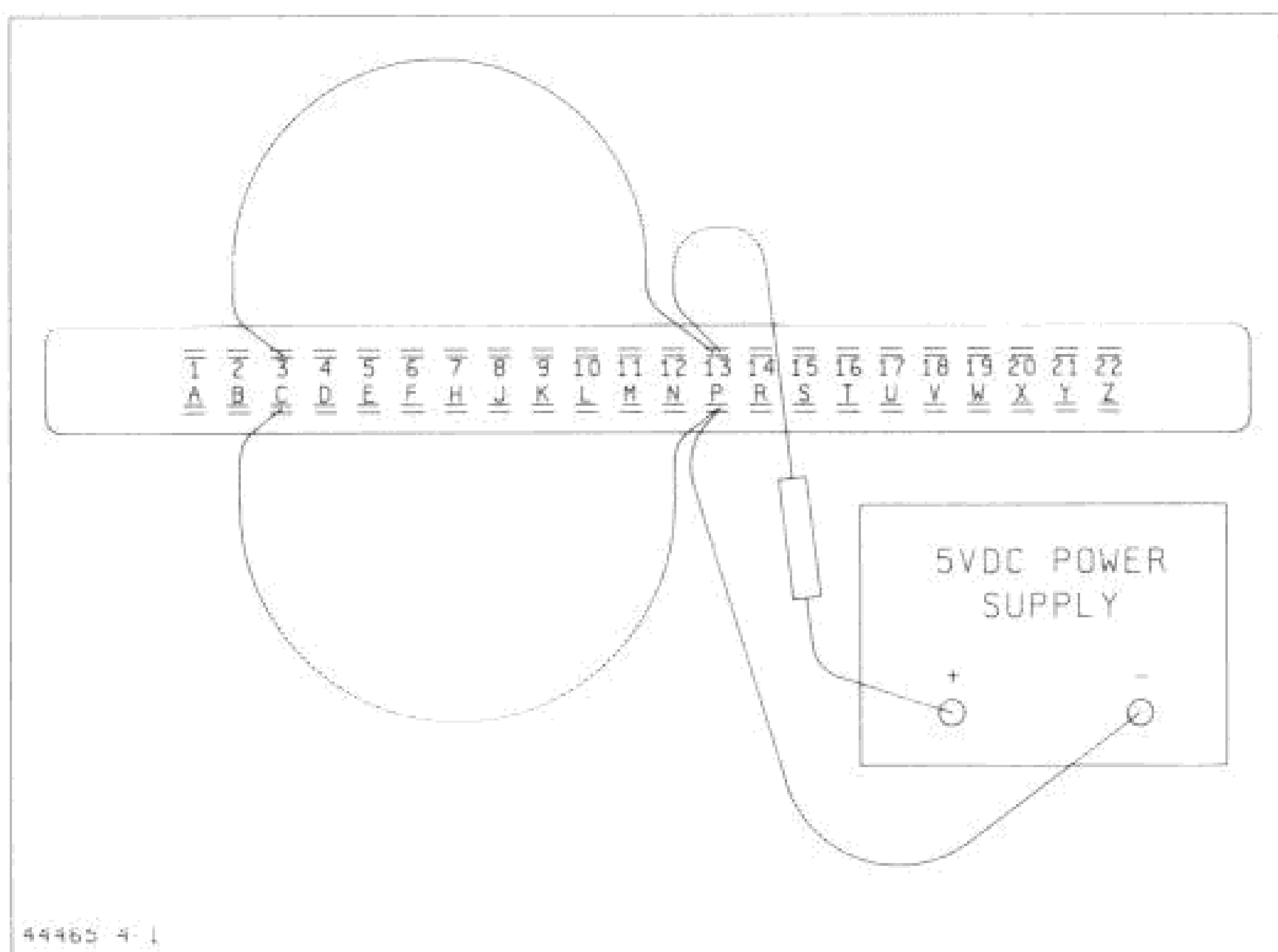



**Figure 3-4-1. Configuring the Terminal Edge Connector**

f. Digital output bit 0 is now wired to digital input bit 0 as shown in Figure 3-4-2. Since the FET switch has a very low on resistance, the input bit should be a "0" when the output bit is closed (i.e., the FET switch is on). When the output bit is opened (the FET switch is off), the input bit should be a "1".

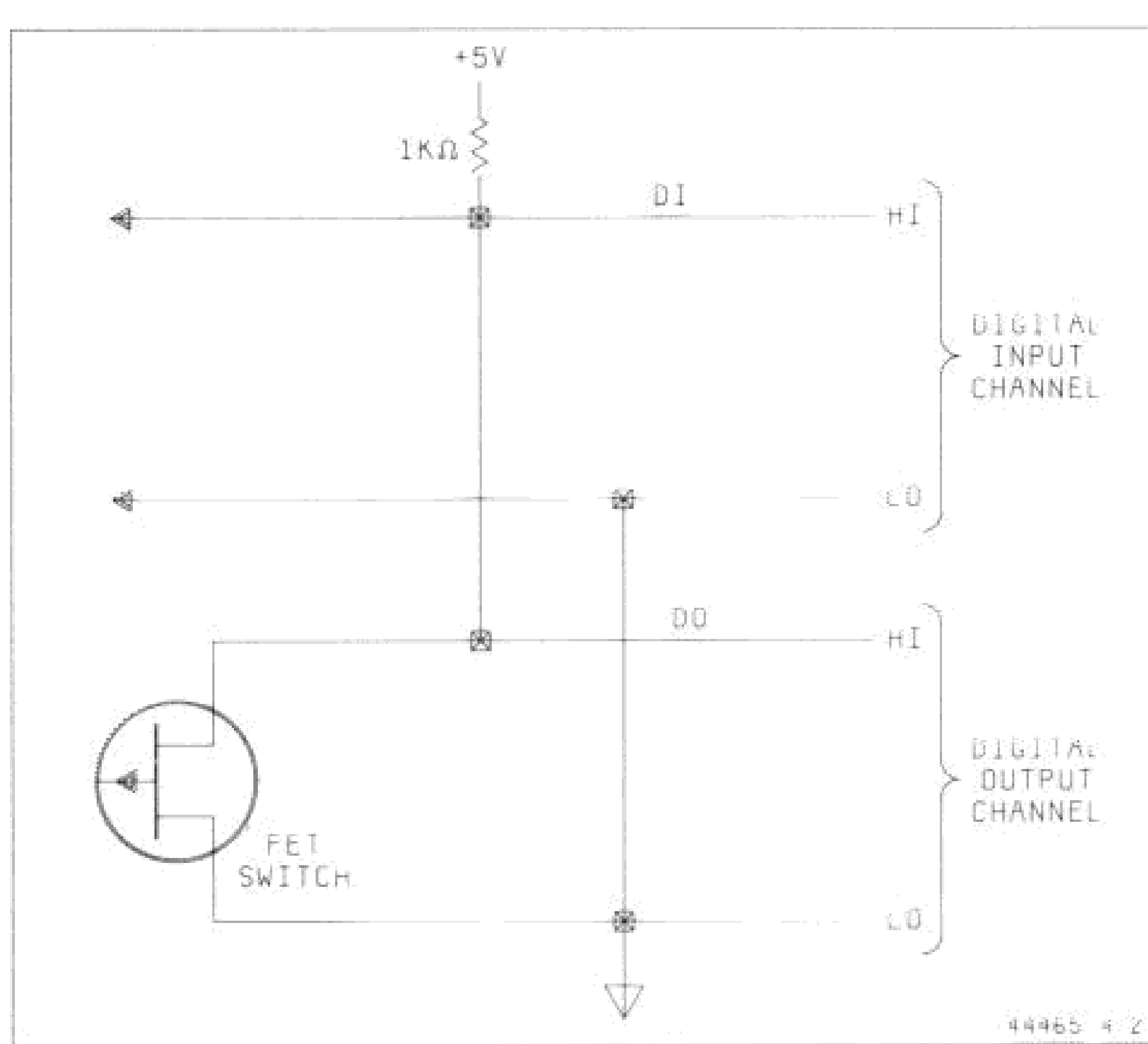



**Figure 3-4-2. Bit Configuration Schematic**

g. Connect the HP-85 I/O cables to the instrument.

h. Press the front panel switch "ON".

i. Run the following program. The HP-85 should be displaying a "0". Check and record the reading on the test card for bit 0 closed. The test card is located at the end of this section.

```
10 OUTPUT 901 ; "CLS0"
20 OUTPUT 901 ; "BIT0"
30 ENTER 901 ; A
40 DISP A
50 END
```

j. Run the program from step i again after modifying line 10 as follows:

```
10 OUTPUT 901 ; "OPN0"
```

k. The HP-85 should now be displaying a "1". Check and record the reading on the test card for bit 0 Open.

l. Reconfigure the terminal block edge connector as follows:

Move the jumper on lug 3 to lug 4
Move the jumper on lug C to lug D
Move the jumpers on lug 13 to lug 14
Move the jumpers on lug P to lug R

m. Run the following program. The HP-85 should be displaying a "0". Check and record the reading on the test card for bit 1 closed.

```
10 OUTPUT 901 ; "CLS1"
20 OUTPUT 901 ; "BIT1"
30 ENTER 901 ; A
40 DISP A
50 END
```

n. Run the program from step m again after modifying line 10 as follows:

```
10 OUTPUT 901 ; "OPN1"
```

o. The HP-85 should now be displaying a "1". Check and record the reading for bit 1 open.

p. Reconfigure the terminal block edge connector as follows:

Move the jumper on lug 4 to lug 5
Move the jumper on lug D to lug E
Move the jumpers on lug 14 to lug 15
Move the jumpers on lug R to lug S

q. Run the following program. The HP-85 should be displaying a "0". Check and record the reading on the test card for bit 2 closed.

```
10 OUTPUT 901 ; "CLS2"
20 OUTPUT 901 ; "BIT2"
30 ENTER 901 ; A
40 DISP A
50 END
```

r. Run the program from step q again after modifying line 10 as follows:

```
10 OUTPUT 901 ; "OPN2"
```

s. The HP-85 should now be displaying a "1". Check and record the reading for bit 2 open.

t. Reconfigure the terminal block edge connector as follows:

Move the jumper on lug 5 to lug 6
Move the jumper on lug E to lug F
Move the jumpers on lug 15 to lug 16
Move the jumpers on lug S to lug T

u. Run the following program. The HP-85 should be displaying a "0". Check and record the reading on the test card for bit 3 closed.

```
10 OUTPUT 901 ; "CLS3"
20 OUTPUT 901 ; "BIT3"
30 ENTER 901 ; A
40 DISP A
50 END
```

v. Run the program from step u again after modifying line 10 as follows:

```
10 OUTPUT 901 ; "OPN3"
```

w. The HP-85 should now be displaying a "1". Check and record the reading for bit 3 open.

x. Reconfigure the terminal block edge connector as follows:

Move the jumper on lug 6 to lug 7
Move the jumper on lug F to lug H
Move the jumpers on lug 16 to lug 17
Move the jumpers on lug T to lug U

y. Run the following program. The HP-85 should be displaying a "0". Check and record the reading on the test card for bit 4 closed.

```
10 OUTPUT 901 ; "CLS4"
20 OUTPUT 901 ; "BIT4"
30 ENTER 901 ; A
40 DISP A
50 END
```

z. Run the program from step y again after modifying line 10 as follows:

```
10 OUTPUT 901 ; "OPN4"
```

aa. The HP-85 should now be displaying a "1". Check and record the reading for bit 4 open.

bb. Reconfigure the terminal block edge connector as follows:

Move the jumper on lug 7 to lug 8
Move the jumper on lug H to lug J
Move the jumpers on lug 17 to lug 18
Move the jumpers on lug U to lug V

cc. Run the following program. The HP-85 should be displaying a "0". Check and record the reading on the test card for bit 5 closed.

```
10 OUTPUT 901 ; "CLS5"
20 OUTPUT 901 ; "BIT5"
30 ENTER 901 ; A
40 DISP A
50 END
```

dd. Run the program from step cc again after modifying line 10 as follows:

```
10 OUTPUT 901 ; "OPN5"
```

ee. The HP-85 should now be displaying a "1". Check and record the reading for bit 5 open.

ff. Reconfigure the terminal block edge connector as follows:

Move the jumper on lug 8 to lug 9
Move the jumper on lug J to lug K
Move the jumpers on lug 18 to lug 19
Move the jumpers on lug V to lug W

gg. Run the following program. The HP-85 should be displaying a "0". Check and record the reading on the test card for bit 6 closed.

```
10 OUTPUT 901 ; "CLS6"
20 OUTPUT 901 ; "BIT6"
30 ENTER 901 ; A
40 DISP A
50 END
```

hh. Run the program from step gg again after modifying line 10 as follows:

```
10 OUTPUT 901 ; "OPN6"
```

ii. The HP-85 should now be displaying a "1". Check and record the reading for bit 6 open.

jj. Reconfigure the terminal block edge connector as follows:

Move the jumper on lug 9 to lug 10
Move the jumper on lug K to lug L
Move the jumpers on lug 19 to lug 20
Move the jumpers on lug W to lug X

kk. Run the following program. The HP-85 should be displaying a "0". Check and record the reading on the test card for bit 7 closed.

```
10 OUTPUT 901 ; "CLS7"
20 OUTPUT 901 ; "BIT7"
30 ENTER 901 ; A
40 DISP A
50 END
```

ll. Run the program from step kk again after modifying line 10 as follows:

```
10 OUTPUT 901 ; "OPN7"
```

mm. The HP-85 should now be displaying a "1". Check and record the reading for bit 7 open.

nn. This completes the operational verification of the Digital I/O Assembly. If any bit failed, it is recommended that it be rechecked before troubleshooting.

## OPERATION TEST CARD

Hewlett-Packard Model 44465A

Digital I/O Assembly

Slot Location________

Test Performed By________

Date________

| Bit Address | Output Bit State | Reading | Should Be | TestPass | Test Fail |
|---|---|---|---|---|---|
| 0, 10, or 20 | Closed | ______ | 0 | ______ | ______ |
| | Open | ______ | 1 | ______ | ______ |
| 1, 11, or 21 | Closed | ______ | 0 | ______ | ______ |
| | Open | ______ | 1 | ______ | ______ |
| 2, 12, or 22 | Closed | ______ | 0 | ______ | ______ |
| | Open | ______ | 1 | ______ | ______ |
| 3, 13, or 23 | Closed | ______ | 0 | ______ | ______ |
| | Open | ______ | 1 | ______ | ______ |
| 4, 14, or 24 | Closed | ______ | 0 | ______ | ______ |
| | Open | ______ | 1 | ______ | ______ |
| 5, 15, or 25 | Closed | ______ | 0 | ______ | ______ |
| | Open | ______ | 1 | ______ | ______ |
| 6, 16, or 26 | Closed | ______ | 0 | ______ | ______ |
| | Open | ______ | 1 | ______ | ______ |
| 7, 17, or 27 | Closed | ______ | 0 | ______ | ______ |
| | Open | ______ | 1 | ______ | ______ |

# SECTION V
# ADJUSTMENTS

3-5-1. This section normally contains instrument adjustment procedures. Since the Model 44465A Digital I/O Assembly has no adjustment procedures, there is no adjustment information in this section.

# SECTION VI
# REPLACEABLE PARTS

3-6-1. This section normally contains information for ordering replaceable parts. However, the replaceable parts for the Model 44465A Digital I/O Assembly are included in Chapter 1 (Mainframe Service Information), Section VI of the manual.

# SECTION VII
# MANUAL CHANGES

### 3-7-1. INTRODUCTION

3-7-2. This section has information to adapt this chapter to the first Digital I/O Assemblies manufactured with HP Part Number 44465-66503 (the current assemblies have part number 44465-66513). This section also adapts the chapter to assemblies having no ERC (Engineering Revision Code) number or a number lower than shown on the title page.

### 3-7-3. Engineering Revision Code (ERC)

3-7-4. The engineering revision code (ERC) is changed whenever a change is made to an assembly. The change could be a printed circuit board revision, a component value change, added or deleted component, a component part number change, or a revised test and assembly procedure. The ERC label is the only one on the printed circuit board that has a four digit number. ERCs were implemented on this instrument with the introduction of the 03421-66511 motherboard. The first ERC was 2334. Refer to Chapter 1 (Mainframe Service Information), Section I for more information on ERC numbers.

### 3-7-5. CHAPTER CHANGES

3-7-6. Most changes in this section apply to the schematics and component locators in Section VIII, and to the parts list (Table 1-6-5) in Chapter 1, Section VI of the manual. If there is only a minor change, like a component value change or a minor circuit change, modify the schematic and Table 1-6-5 presently in the manual. If a major change to a schematic is made, refer to the schematic and component locator in this section of the chapter, instead of Section VIII.

3-7-7. If the ERC number is not listed on the title page or in this section, refer to the supplied *MANUAL CHANGES* supplement for updating information. Also, if a *MANUAL CHANGES* supplement is supplied, make all indicated ERRATA changes to correct any errors in this chapter.

### CHANGE 1

#### Description

This change applies to Digital I/O Assemblies with HP Part Number 44465-66503. This number was for sale in the United States and Canada only. To adapt this manual for use with HP Part Number 44465-66503, use the component locator shown in Figure 3-7-1 instead of the one shown in Section VIII.

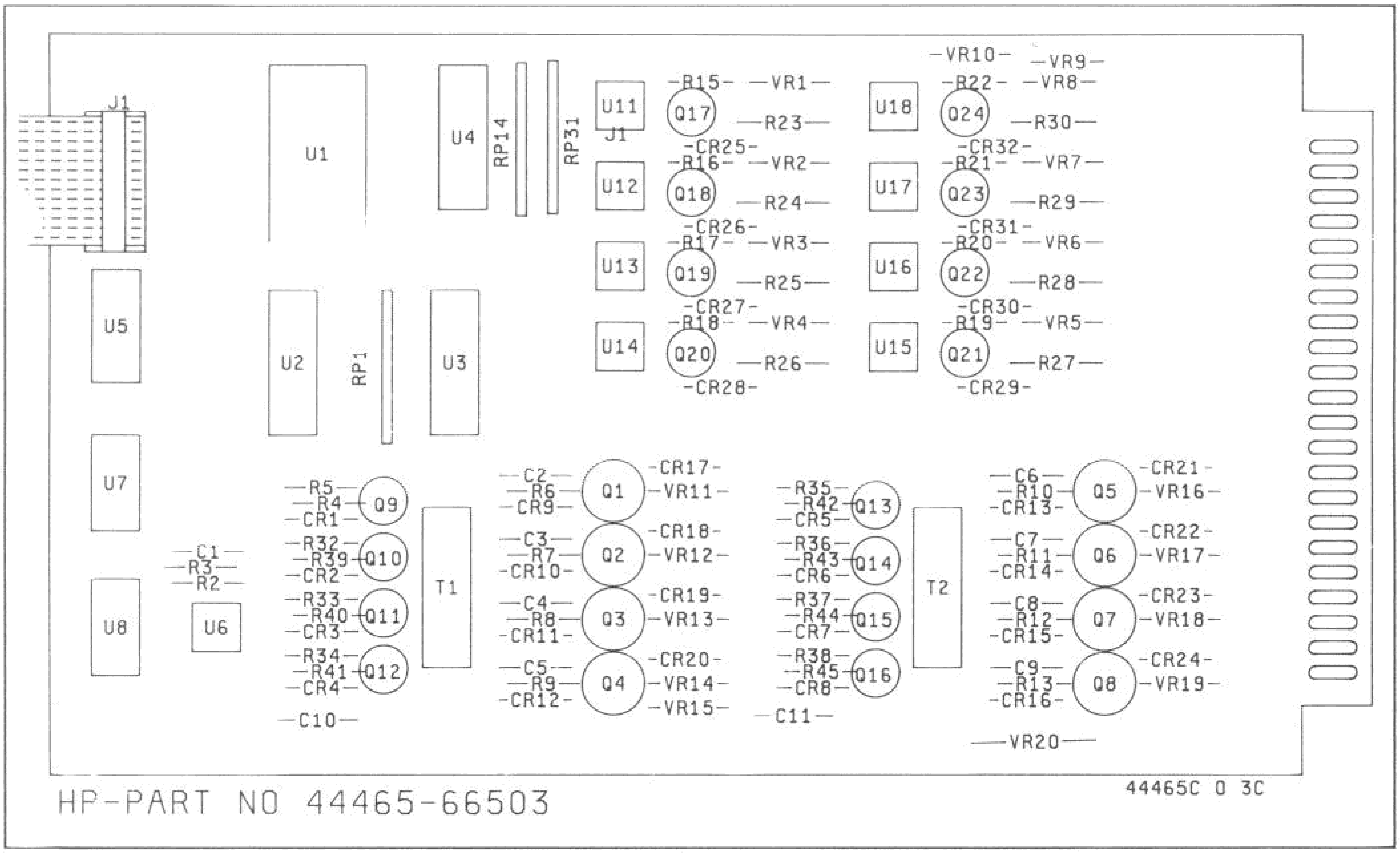



**Figure 3-7-1. Component Locator (Change 1)**

# SECTION VIII
# SERVICE

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 3-8-1. INTRODUCTION

3-8-2. This section contains the theory of operation and troubleshooting information for the Digital I/O Assembly.

## 3-8-3. THEORY OF OPERATION

### 3-8-4. General

3-8-5. The Digital I/O Assembly has eight input and eight output bits. The input bits are isolated with optoisolators. The output bits are transformer isolated. The inputs are typically used to monitor the state of limit switches, valves, etc.. The outputs are typically used as low voltage and current actuators.

3-8-6. There are three ground references on the assembly that become important when troubleshooting. On input bits, the LO of the bit being checked is the reference for all components that are connected anywhere between the terminal block edge connector and the input to the optoisolator (see schematic (Figure 3-8-3)). On output bits, the LO of the bit being checked is the reference for all components that are connected anywhere between the output of the transformer and the terminal block edge connector (see schematic (Figure 3-8-4)). All other components on the assembly are referenced to mainframe ground.

### 3-8-7. Signal Level Requirements

3-8-8. A logic "1" is recognized when reading input bits that have voltage levels anywhere between 2V and 24V. An output bit can sink up to 300mA, not to exceed 0.6VA.

### 3-8-9. Communication With The Mainframe

3-8-10. Signal line DI (DI0-DI2, depending upon the slot) is used to serially transfer data from U1 to the mainframe. Signal line SD is used by the mainframe to serially output data to the Digital I/O Assembly. Mainframe communication is explained in more detail in the following paragraphs.

**3-8-11. Input Bits.** A schematic of one digital input is shown in Figure 3-8-1. For a "1" to be recognized, the input voltage can be anywhere between 2V and 24V. Any voltage less than 2V will be recognized as a "0". The zener diode across the input provides a 10V clamp for protection. The transistor will sink excess current away from the input of the optoisolator. The varistor provides additional protection from voltage transients.

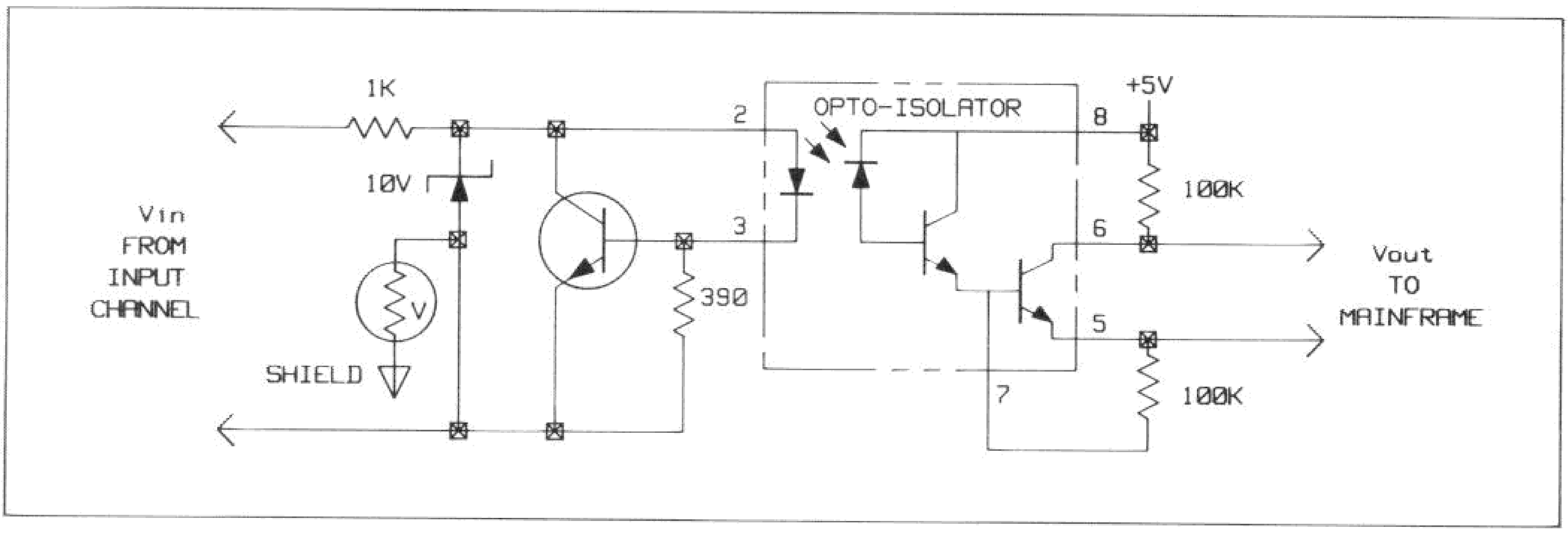



**Figure 3-8-1. Schematic of One Digital Input**

3-8-12. Input signals are inverted at Vout. These input signals pass through the U4 buffer and are latched into the U1 latching shift register. Signal line CLK serially shifts the data out of U1 to the mainframe via the DI line.

3-8-13. Signal line HDS2 controls whether U1 is in the serial or parallel mode. When HDS2 is low, U1 is in the serial mode; when HDS2 is high, U1 is in the parallel mode. The parallel mode is entered to latch the U1 inputs. The serial mode is entered to serially shift the U1 contents to the mainframe.

3-8-14. Signal line A (A0-A2, depending upon the slot) is an enable line for U1. When this line is high, U1 is enabled. The remaining signal lines (SD, DOE, and B0-B2) are used to write output bits.

**3-8-15. Output Bits.** A schematic representation of one digital output is shown in Figure 3-8-2. Refer to this figure and the schematic of Figure 3-8-4 for the following explanation.

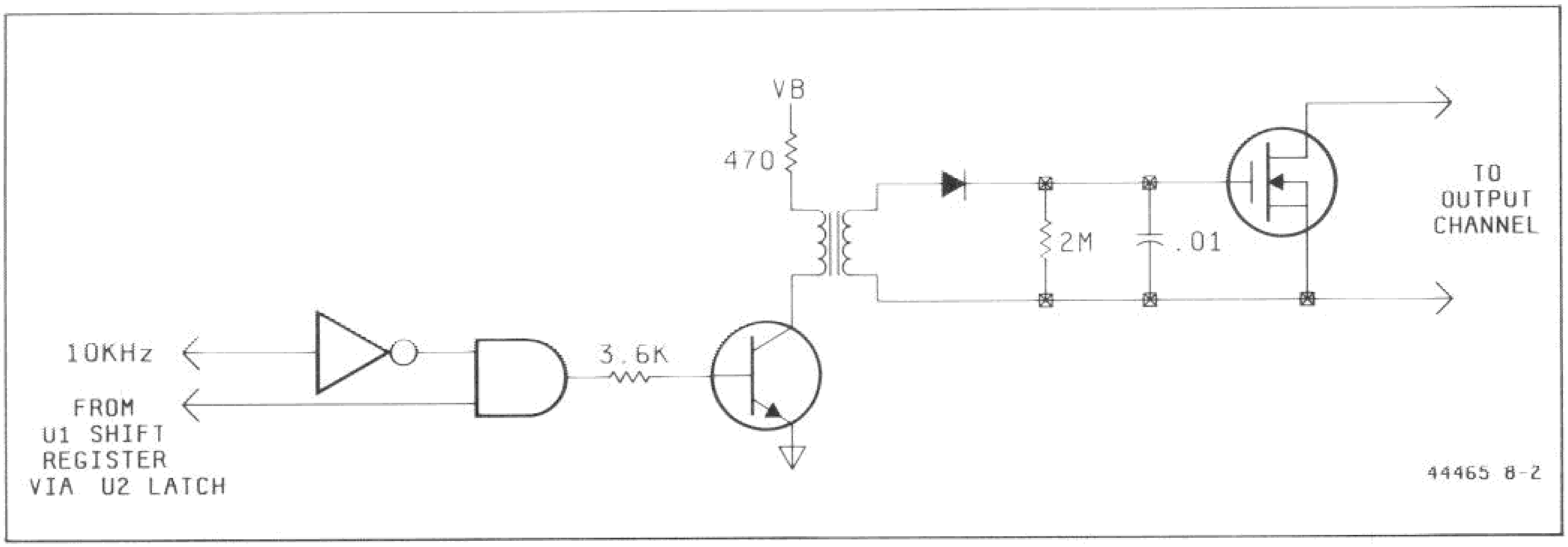



**Figure 3-8-2. Schematic of One Digital Output**

3-8-16. Like input bits, outputs from the mainframe to the Digital I/O Assembly are transferred serially. The information, however, is transferred over the SD line to the U1 latching shift register. When the shift register is full, it outputs a byte which is latched into U2 by signal B (B0-B2, depending upon the slot). The U2 latch provides signals to one input of the AND gates that are associated with the various bits. The other input to the AND gates is a 10 kHz square wave. Hence, it is the U2 latch outputs that enable and disable the AND gates.

3-8-17. When an output bit is to be closed (e.g., "CLS0" is executed), the output of the AND gate associated with that bit will go high during the high period of the 10 kHz signal. This causes the bipolar transistor associated with that bit to turn on. When the transistor turns on, it pulses the transformer primary, which causes a capacitor on the secondary to charge. This places a positive voltage on the gate of the VMOS FET which causes the source to drain resistance to be very small (typically about 2 Ω).

3-8-18. When an output bit is to be opened (e.g., "OPN0" is executed), the U2 output line corresponding to that bit is low. This disables the output of the AND gate associated with that bit, thereby not allowing the transistor to pulse the transformer, which in turn does not allow the VMOS FET to turn on. When the FET is off, the source to drain resistance is very high (typically greater than 10 MΩ).

3-8-19. Signal line DOE (Digital Output Enable) is low at all times except power-on or reset. At these times DOE is driven momentarily high. This ensures that the U2 latch is cleared, which in turn ensures that all digital output bits are cleared at power-on, or if a reset occurs. Signal line B (B0-B2, depending upon the slot), is a latch enable line for U2. When signal B goes high, U2 will latch its inputs, assuming that DOE is low.

3-8-20. U3 is an inverting buffer that provides a means of reading back an output. This is done only when writing to outputs to determine which bits need to be changed. When outputs are read, it is similar to reading inputs. The inversion, therefore, is necessary because of the inversion that takes place when inputs are read.

## 3-8-21. TROUBLESHOOTING

3-8-22. Troubleshooting procedures are given for the following failures:

Low input bit reads high
High input bit reads low
Unable to close an output bit
Unable to open an output bit

3-8-23. If a problem is encountered when writing an output, it is suggested that you make sure the inputs are OK before troubleshooting an output problem. This is because, when writing an output, the state of U2 is read back via U3 to determine which bits are to be altered. This was explained in the theory of operation. Thus, a problem in writing outputs could actually be caused by a portion of the input circuitry.

3-8-24. These procedures use input bit 0 and output bit 0 as examples for troubleshooting. This will guide you in troubleshooting a particular bit(s). However, you will have to refer to the schematic and substitute pin numbers and components, depending upon which bit you are troubleshooting.

3-8-25. In the procedures, it is assumed that the Interface Select Code is "9" and the device address is "01" (i.e., "901"). This is typical when using the HP-IL interface and the instrument is the first device in the loop. The procedures can also be used with HP-IB if the proper interface select code and device address are specified (e.g., "709" in place of "901").

3-8-26. Bit addresses are slot dependent. The procedures use bit 0 for the option in slot 0. The bit address will have to be modified to correspond to the bit being checked. The bit addresses for the various slots are specified as follows:

| Slot Number of Option | Specify Bit |
|---|---|
| 0 | 0- 7 |
| 1 | 10-17 |
| 2 | 20-27 |

3-8-27. If the option is in slot 0, and some other option occupies slot 1, the slot 1 option must to be removed to access the slot 0 option components. If the option is in slot 1 or slot 2, all components can be accessed without removing another option.

### 3-8-28. Low Input Bit Reads High

3-8-29. If this problem shows up on all bits, suspect a problem with U4, U1, or the mainframe. If the problem shows up on a specific bit(s), the problem can be any device associated with that input bit. To troubleshoot this problem, do the following:

a. Connect the I/O cables between the computer and the instrument.

b. Use a cliplead jumper and short LO0 to HI0 on the terminal block edge connector (i.e. short the two inputs to the bit to be checked).

c. Run the following program. Modify the bit address to correspond to the bit to be checked as required.

```
10 OUTPUT 901 ; "BIT0"
20 ENTER 901 ; A
30 DISP A
40 GOTO 10
50 END
```

d. The computer should be displaying a 0. If it is, then that bit is OK. If it is displaying a 1, proceed with step e.

e. Connect the ground lead of an oscilloscope probe to LO0 of input bit 0 on the terminal block edge connector (or the LO terminal of the input bit being checked). Then probe U11 pin 2 (or U12-U18 pin 2, depending upon the bit) for a ground potential. Notice that pin 1 on the optoisolators is oriented differently than pin 1 on the other ICs. If U11 pin 2 is not a solid ground, make sure the ground lead of the probe is connected to the LO of the input bit being checked. If the probe is connected properly, check R15 and R23 (or the resistors associated with the input bit being checked). If the resistors are OK, make sure there are no broken traces on either the HI or LO line for that bit. If U11 pin 2 is at a potential greater than ground, replace U11.

f. Move the ground lead of the scope probe to mainframe ground.

g. Probe U11 pin 6 (or pin 6 of U12-U18, depending upon the bit), for +5V. If it is correct, proceed with step h. If it is wrong, replace U11 (or the optoisolator associated with that bit.

h. Check U4 pin 17 (or the input pin associated with the bit you are checking) for +5V. If it is correct, proceed with step i. If it is wrong, check the trace between the optoisolator and the U4 buffer.

i. Check U4 pin 3 (or the output pin associated with the bit you are checking) for +5V. If it is OK, proceed with step j. If it is wrong (less than 3V), check U4 pins 1 and 19 to make sure transitions are occurring. If transitions are occurring, replace U4. If they are not occurring, check U5 pin 14 to see if transitions are occurring. If they are occurring at U5 pin 14, replace U5. If transitions are not occurring at U5 pin 14, the problem is with the SD line and could be on the mainframe or the ribbon cable going to the mainframe.

j. Check U1 pin 8 (or the pin associated with the bit being checked) for the same level that was observed at U4 pin 3 in the previous step. If it is OK, proceed with step k. If it is wrong, check the trace between U4 pin 3 and U1 pin 8 (or the trace associated with the bit being checked).

k. Check U1 pin 23 for periodic positive going TTL transitions. This is the serial data line going to the mainframe (DI0-DI2, depending upon the slot). If this line is making transitions, the Digital I/O Assembly is probably OK, and the problem is most likely on the mainframe. If this line is not making transitions, do the following:

1. Check signal line A (A0-A2, depending upon the slot). It should be at about a +5V level.

2. Check signal line CLK. It should be making positive going TTL transitions.

3. Check signal line HDS2. It should be making positive going TTL transitions. HDS2 has a very short pulse width, and may be difficult to view.

4. If A, CLK, and HDS2 are all OK, replace U1. If either is wrong, suspect a problem with the ribbon cable, ribbon cable connectors, or the mainframe.

### 3-8-30. High Input Bit Reads Low

3-8-31. If this problem shows up on all bits, suspect a problem with U4, U1, or the mainframe. If the problem shows up on a specific bit(s), the problem can be any device that handles the input bit. To troubleshoot this problem, do the following:

a. Connect the I/O cables between the computer and the instrument.

b. On the terminal block edge connector, connect a 5V power supply to the input bit to be checked. Connect the HI side of the supply to the HI lug of the input bit and the LO side to the LO lug.

c. Run the following program. If necessary, modify the bit address to correspond to the bit to be checked.

```
10 OUTPUT 901 ; "BIT0"
20 ENTER 901 ; A
30 DISP A
40 GOTO 10
50 END
```

d. The computer should be displaying a 1. If it is, then that bit is OK. If it is displaying a 0, proceed with step e.

e. Connect the ground lead of an oscilloscope probe to LO0 of input bit 0 on the terminal block edge connector (or the LO terminal of the input bit being checked). Then probe U11 pin 2 (or U12-U18 pin 2, depending upon the bit) for a +5V level. Notice that pin 1 on the optoisolators is oriented differently than pin 1 on the other ICs. If U11 pin 2 is incorrect, first make sure the oscilloscope probe ground lead is referenced to LO of the input bit being checked. If the probe is connected properly, check R15, R23, Q17, and CR25. If these components are OK, make sure there are no broken traces on either the HI or LO line for that bit.

f. Move the ground lead of the scope probe to mainframe ground.

g. Probe U11 pin 6 (or pin 6 of U12-U18, depending upon the bit), for 0V. If it is correct, proceed with step h. If it is wrong, replace U11 (or the optoisolator associated with that bit).

h. Check U4 pin 17 (or the input pin associated with the bit you are checking) for 0V. If it is correct, proceed with step i. If it is wrong, check the trace between the optoisolator and the U4 buffer.

i. Check U4 pin 3 (or the output pin associated with the bit you are checking) for 0V. If it is OK, proceed with step j. If it is wrong, first check U4 pins 1 and 19 to make sure transitions are occurring. If transitions are occurring, replace U4. If they are not occurring, check U5 pin 14 to see if transitions are occurring. If they are occurring at U5 pin 14, replace U5. If transitions are not occurring at U5 pin 14, the problem is with the SD line and could be on the mainframe or the ribbon cable going to the mainframe.

j. Check U1 pin 8 (or the pin associated with the bit being checked) for the same level that was observed at U4 pin 3 in the previous step. If it is OK, proceed with step k. If it is wrong, check the trace between U4 pin 3 and U1 pin 8 (or the trace associated with the bit being checked).

k. Check U1 pin 23 for periodic positive going TTL pulses. This is the serial data line going to the mainframe (DI0-DI2, depending upon the slot). If this line is making transitions, the Digital I/O Assembly is probably OK, and the problem is most likely on the mainframe. If this line is not making transitions, do the following:

1. Check signal line A (A0-A2, depending upon the slot). It should be at about a +5V level.

2. Check signal line CLK. It should be making positive going TTL transitions.

3. Check signal line HDS2. It should be making positive TTL transitions. HDS2 has a very short pulse width, and may be difficult to view.

4. If A, CLK, and HDS2 are all OK, replace U1. If either is wrong, suspect a problem with the ribbon cable, ribbon cable connectors, or the mainframe.

### 3-8-32. Unable to Close a Digital Bit

3-8-33. If none of the digital bits will close, suspect U1, U2, U5e, or U6, or a mainframe problem. If the problem shows up on a specific bit(s), it could be any component on the assembly that is associated with that bit.

3-8-34. To troubleshoot a specific bit, refer to paragraph 3-8-35. However, if none of the bits will close, do the following:

a. Connect the I/O cables between the instrument and the computer.

b. Connect the oscilloscope probe ground lead to mainframe ground.

c. Check U5 pin 12 for positive going TTL pulses with a frequency of about 10 kHz. If these pulses are OK, proceed with step d. If they are not OK, do the following:

1. Check U6 pin 3 for negative going TTL pulses with a frequency of about 10 kHz. If U6 pin 3 is not OK, replace U6. U6 pin 3 is OK, replace U5.

d. Run the following program. Modify the bit address to correspond to the proper slot (e.g., if the option is in slot 1, specify "CLS10" on line 10).

```
10 OUTPUT 901 ; "CLS0"
20 GOTO 10
30 END
```

e. Monitor U1 pin 23 to see if it is making transitions. If it is, U1 and the U1 control signals are probably OK, in which case you should proceed with step f. If U1 pin 23 is not making transitions, do the following:

1. Check the following signals for the states noted.

| Signal | Check At | State |
|---|---|---|
| SD | U1 pin 10 | Making TTL transitions |
| A | U1 pin 9 | TTL high |
| CLK | U1 pin 15 | Making TTL transitions |
| HDS2 | U1 pin 13 | Making TTL transitions |

2. If the preceeding signals are correct, but U1 pin 23 is not making transitions, replace U1. If any of the preceeding signals are wrong, suspect a problem on the mainframe or the ribbon cable going to the mainframe.

f. Monitor U2 pin 2 to make sure it is a TTL high. If U2 pin 2 is OK, then U2 is probably OK. However, if U2 pin 2 checked OK, but you are still unable to close any output bit, suspect U3 or a mainframe problem. Another somewhat remote possibility would be that both U7 and U8 are defective. If U2 pin 2 is not OK, do the following:

1. Check U2 pin 1 (signal DOE) to make sure it is 0V. If it is a TTL high, it will keep the U2 latch cleared. This is most likely a mainframe problem.

2. Check U2 pin 11 (signal B0-B2, depending upon the slot), for positive going TTL pulses. If U2 pin 11 is not OK, it could be a mainframe problem or a defective ribbon cable.

3. If U2 pin 1 and pin 11 both checked OK, but U2 pin 2 was not a TTL high, replace U2.

3-8-35. Use the following procedure to check a single bit. The procedure assumes that the option is in slot 0 and that bit 0 is being checked. Modify the bit address as required, depending upon the bit being checked.

a. Connect the I/O cables between the computer and the instrument.

b. Run the following program. Modify the bit address as required.

```
10 OUTPUT 901 ; "CLS0"
20 GOTO 10
30 END
```

c. On the terminal block edge connector, connect an external ohmmeter (like the HP 3456A) between HI and LO of the bit being checked. If the reading is 2 Ω or less, the bit is OK. If the reading is 10 MΩ or greater, proceed with step d. If the reading is greater than 2 Ω but less than 10 MΩ, the problem is most likely the FET associated with the bit being checked (Q1-Q8).

d. With the scope probe referenced to LO of the ouput bit being checked, probe the cathode of CR16 (or the cathode of the diode associated with that bit) for a dc voltage of about 6V. If it is OK, replace the FET associated with that bit. If the voltage is low, proceed with step e.

e. Check the anode of CR16 (or the anode of the diode associated with that bit) for spikes that are approximately 15V p-p. If the spikes are observed on the anode, but a dc voltage is not observed on the cathode, replace the diode associated with the bit being checked. If that doesn't solve the problem, replace C9 (or the capacitor associated with that bit). If spikes are not observed on the anode, proceed with step f.

f. Move the ground lead of the oscilloscope probe to instrument ground.

g. Check the collector of Q16 (or the bipolar transistor associated with the bit being checked) for a signal that pulses from 8V to 0V, approximately. The high level of the signal will depend upon the VB voltage. If this signal is correct, replace the transformer. If it is not correct, proceed with step h.

h. Check Q16 (or the bipolar transistor associated with the bit being checked) for a shorted junction. Also check the collector diode (CR8 for bit 0), and the transformer primary continuity. If these devices are OK, proceed with step i.

i. Check U8 pin 2 for positive going TTL pulses with a frequency of about 10 kHz. If it is OK, proceed with step j. If U8 pin 2 is incorrect, do the following:

1. Check U6 pin 3 for negative going TTL pulses with a frequency of about 10 kHz. If U6 pin 3 is OK, replace U5. If U6 pin 3 is incorrect, replace U6.

j. Check U8 pin 1 for a TTL high. Refer to the schematic and modify the U8 (or U7) pin number, depending upon the bit being checked. If U8 pin 1 is OK, replace U8 (or U7, depending upon the bit being checked). If U8 pin 1 is incorrect, do the following:

1. Check U2 pin 3 to see if it is making transitions. If it is wrong, proceed with step k. If U2 pin 3 is OK, perform step 2.

2. Check U2 pin 1 (signal DOE) for a TTL low, and U2 pin 11 (signal B0-B2, depending upon the slot) for periodic positive going transitions. If either signal is incorrect, suspect a problem on the mainframe, or the ribbon cable going to the mainframe. If both signals are OK, but U2 pin 2 does not set, replace U2.

k. Check the following signal lines. If all lines are OK, replace U1. If any line is bad, suspect a mainframe problem or a defective ribbon cable.

| Signal | Check At | State |
|---|---|---|
| SD | U1 pin 10 | Making TTL transistions |
| A | U1 pin 9 | TTL high |
| CLK | U1 pin 15 | Making TTL transitions |
| HDS2 | U1 pin 13 | Making TTL transitions |

### 3-8-36. Unable to Open a Digital Bit

3-8-37. If none of the digital bits will open, suspect U1 or U2, or a mainframe problem. If the problem shows up on a specific bit(s), it could be any component on the assembly that is associated with that bit.

3-8-38. To troubleshoot a specific bit, refer to paragraph 3-8-39. However, if none of the bits will open, do the following:

a. Connect the I/O cables between the instrument and the computer.

b. Connect the oscilloscope probe ground lead to mainframe ground.

c. Run the following program. Modify the bit address to correspond to the proper slot (e.g., if the option is in slot 1, specify "OPN0" on line 10).

```
10 OUTPUT 901 ; "OPN0"
20 GOTO 10
30 END
```

d. Monitor U1 pin 23 to see if it is making transitions. If it is, U1 and the U1 control signals are probably OK, in which case you should proceed with step e. If U1 pin 23 is not making transitions, do the following:

1. Check the following signals for the states noted.

| Signal | Check At | State |
|---|---|---|
| SD | U1 pin 10 | Making TTL transitions |
| A | U1 pin 9 | TTL high |
| CLK | U1 pin 15 | Making TTL transitions |
| HDS2 | U1 pin 13 | Making TTL transitions |

2. If the preceeding signals are correct, but U1 pin 23 is not making transitions, replace U1. If any of the preceeding signals are wrong, suspect a problem on the mainframe or the ribbon cable going to the mainframe.

e. Monitor U2 pin 2 to make sure it is a TTL low. If U2 pin 2 is OK, then U2 is probably OK. However, if U2 pin 2 checked OK, but you are still unable to open any output bit, suspect U3 or a mainframe problem. Another somewhat remote possibility would be that both U7 and U8 are defective. If U2 pin 2 is not OK, do the following:

1. Check U2 pin 11 (signal B0-B2, depending upon the slot), for positive going TTL pulses. If U2 pin 11 is not OK, it could be a mainframe problem or a defective ribbon cable.

2. U2 pin 1 (signal DOE) should be 0V. However, even if DOE is a TTL high, it will not affect bit openings. A TTL high on DOE will not allow a bit to be closed.

3. If U2 pin 1 and pin 11 both checked OK, but U1 pin 2 was not a TTL low, replace U2.

3-8-39. Use the following procedure to check a single bit. The procedure assumes that the option is in slot 0 and that bit 0 is being checked. Modify the bit address as required, depending upon the bit being checked.

a. Connect the I/O cables between the computer and the instrument.

b. Run the following program. Modify the bit address as required.

```
10 OUTPUT 901 ; "OPN0"
20 GOTO 10
30 END
```

c. On the terminal block edge connector, connect an external ohmmeter (like the HP 3456A) between HI and LO of the bit being checked. If the reading is 10 MΩ or more, the bit is open. If the reading is less than 10 MΩ, proceed with step d.

d. With the ground lead of the oscilloscope probe referenced to LO of the channel, check the anode of CR16 (or the anode of the diode associated with the channel being checked) to make sure it is 0V. If it is 0V, the problem is with the FET associated with the channel being checked. If spikes are observed on the anode of the diode, the problem could be U1, U2, or U3, or the control signals associated with U1 or U2. Do the following:

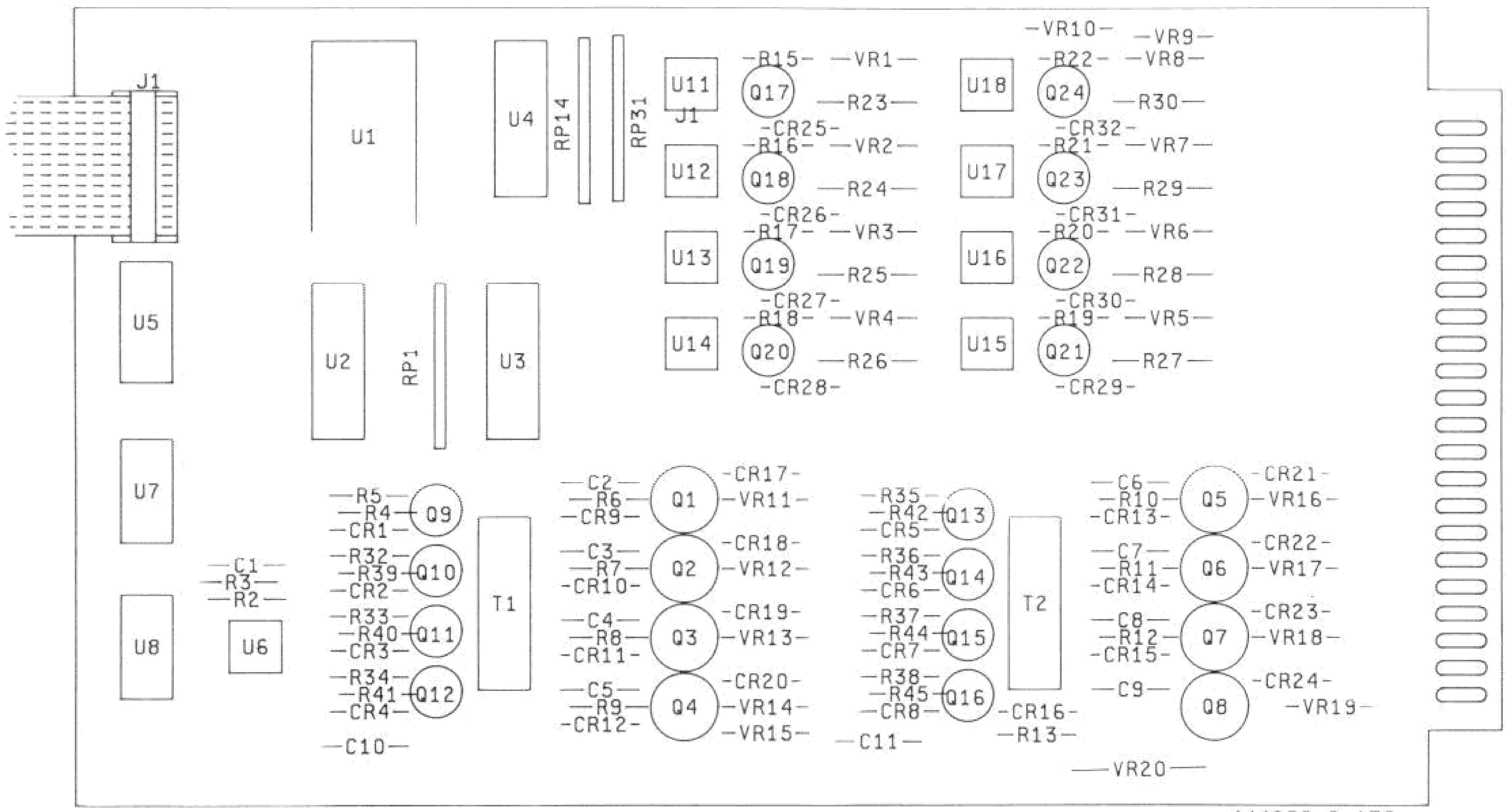
1. Check U2 pin 2 to see if it is 0V. If it is, but spikes are observed on the anode of the diode, replace U8 (or U7, depending upon the bit being checked). If U2 pin 2 is high, check U2 pin 3 to make sure it is making transitions. If it is, perform step 2. If U2 pin 3 is high, skip step 2 and perform step 3.

2. Check signal B (B0-B2, depending upon the slot) for periodic positive going pulses. If signal B is incorrect, suspect a problem on the mainframe, or the ribbon cable going to the mainframe. If signal B is OK, but U2 pin 2 is not 0V, replace U2.

3. Check the following U1 control signals. If they are all correct, replace U1. If any are incorrect, suspect a problem on the mainframe or the ribbon cable going to the mainframe.

| Signal | Check At | State |
|---|---|---|
| SD | U1 pin 10 | Making TTL transitions |
| A | U1 pin 9 | TTL high |
| CLK | U1 pin 15 | Making TTL transitions |
| HDS2 | U1 pin 13 | Making TTL transitions |

4. If all the components appear to check OK, but a bit cannot be opened, replace U3. If that doesn't solve the problem, the problem is most likely on the mainframe.

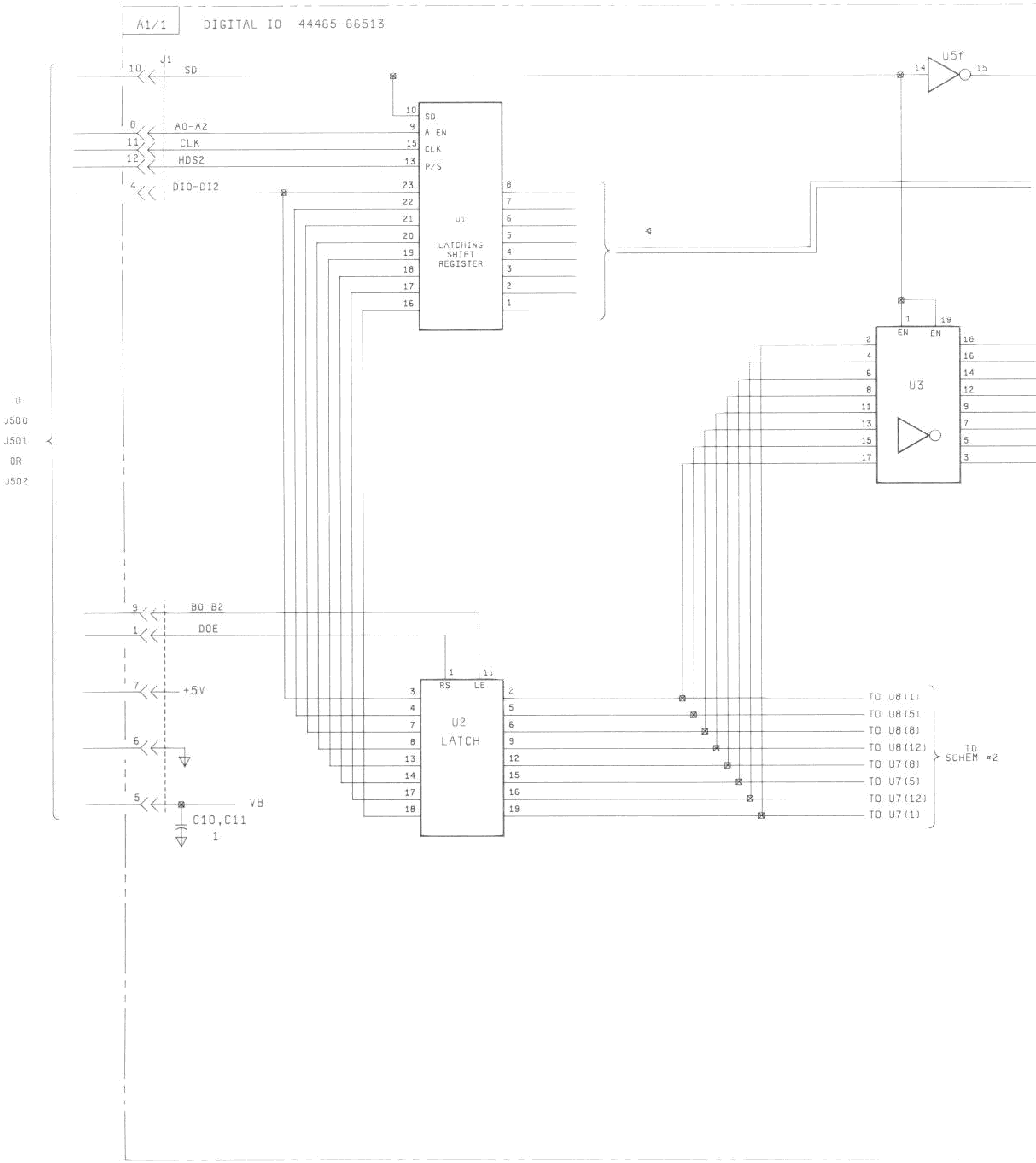


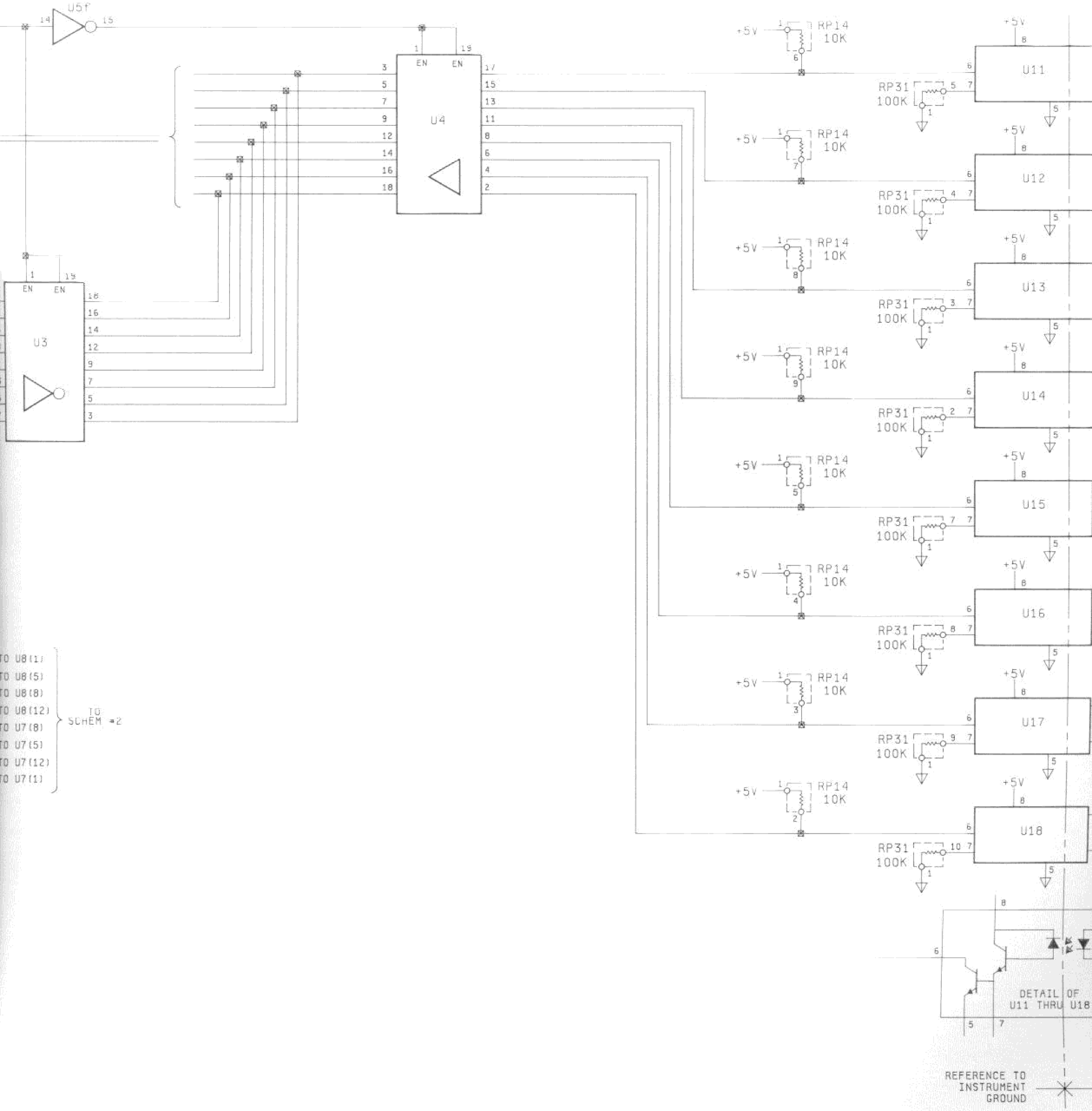

44465C 0 13C

HP-PART NO 44465-66513

**IC Power Supply Configurations**

| IC # | Type | HP P/N | VB | +5V | GND |
|---|---|---|---|---|---|
| U1 | MC14034 | 1820-2232 | – | 24 | 11,12,14 |
| U2 | MM74C373N | 1820-2215 | – | 20 | 10 |
| U3 | MM74C240N | 1820-2538 | – | 20 | 10 |
| U4 | MM74C244N | 1820-2537 | – | 20 | 10 |
| U5 | MC14049UBCP | 1820-1746 | – | 1,3,5,9,11 | 8 |
| U6 | ICM7555IPA | 1820-2466 | – | 4,8 | 1 |
| U7,U8 | MC14081BCP | 1820-1486 | – | 14 | 7 |
| U11-18 | OPTO ISLR | 1990-0545 | – | 2,8 | 5 |


A1/1
DIGITAL IO 44465-66513
J1
SD
A0-A2
CLK
HDS2
DI0-DI2
U1
LATCHING
SHIFT
REGISTER
U5f
U3
EN
TO
J500
J501
OR
J502
B0-B2
DOE
+5V
VB
C10,C11
RS
LE
U2
LATCH
TO U8(1)
TO U8(5)
TO U8(8)
TO U8(12)
TO U7(8)
TO U7(5)
TO U7(12)
TO U7(1)
TO
SCHEM #2


U5f
U4
U3
EN
+5V
RP14
10K
RP31
100K
U11
U12
U13
U14
U15
U16
U17
U18
TO U8(1)
TO U8(5)
TO U8(8)
TO U8(12)
TO U7(8)
TO U7(5)
TO U7(12)
TO U7(1)
TO SCHEM #2
DETAIL OF
U11 THRU U18
REFERENCE TO
INSTRUMENT
GROUND

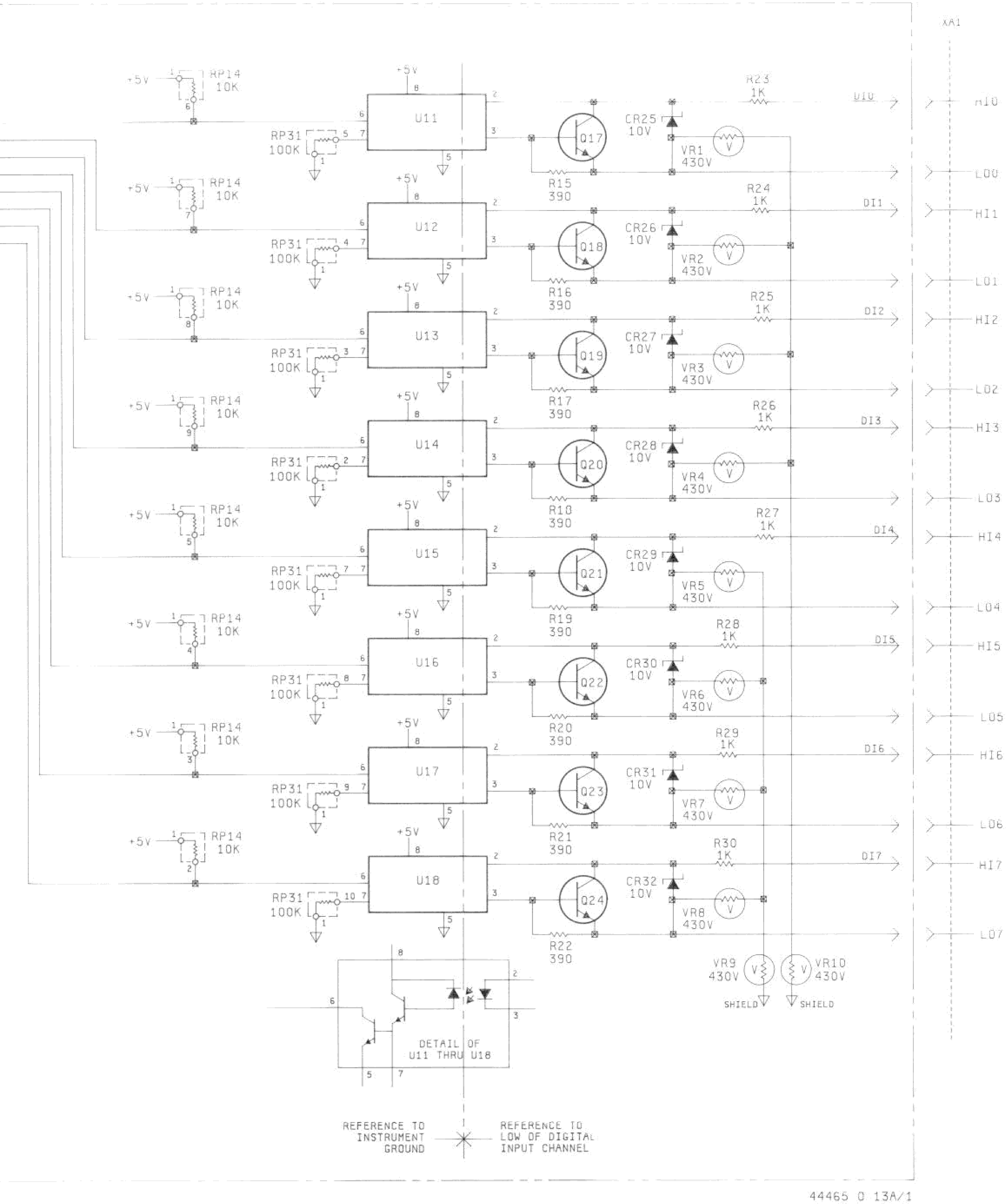
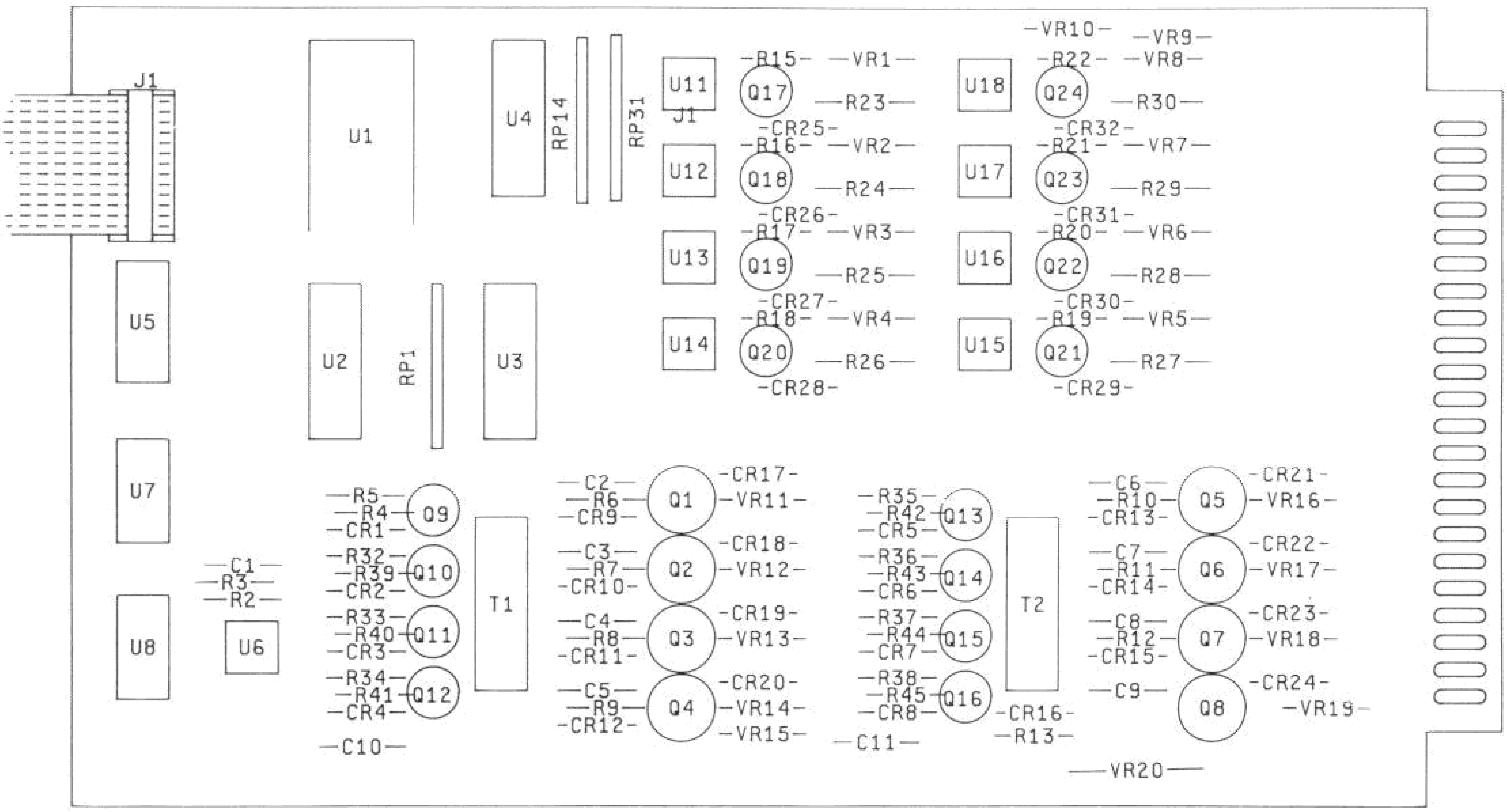



Figure 3-8-3. Digital I/O Assembly, Input Circuitry



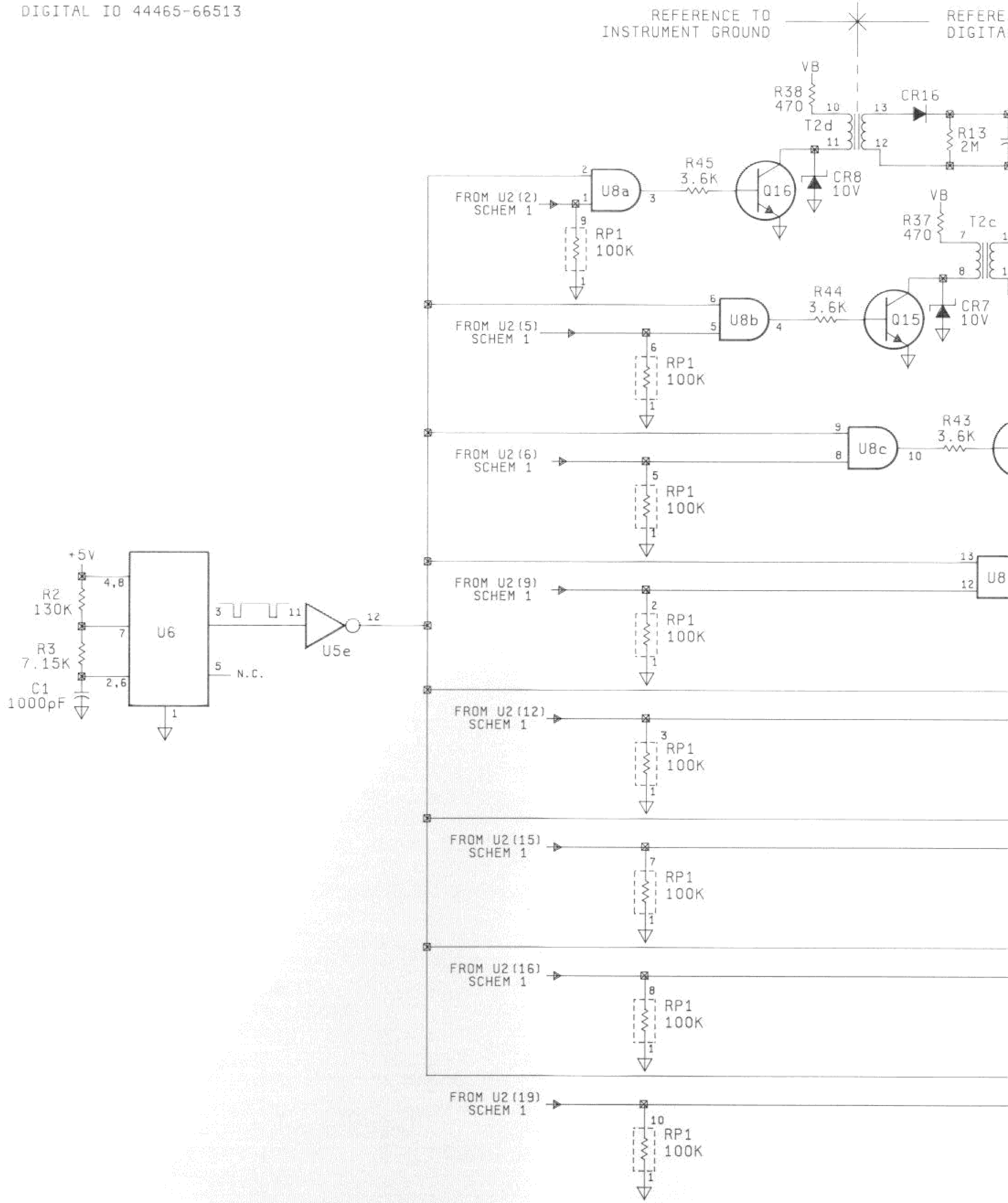

44465C 0 13C

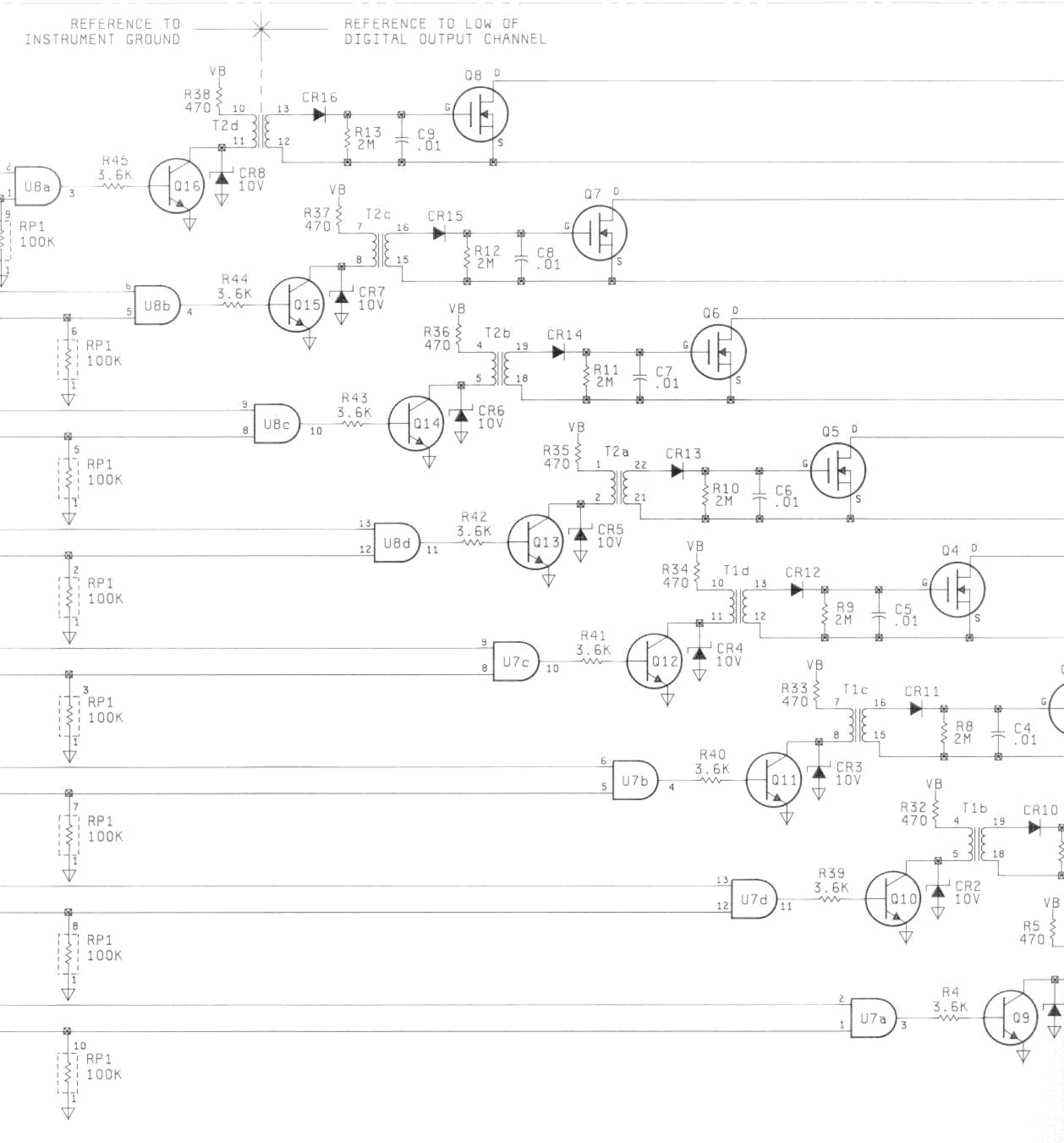
HP-PART NO 44465-66513

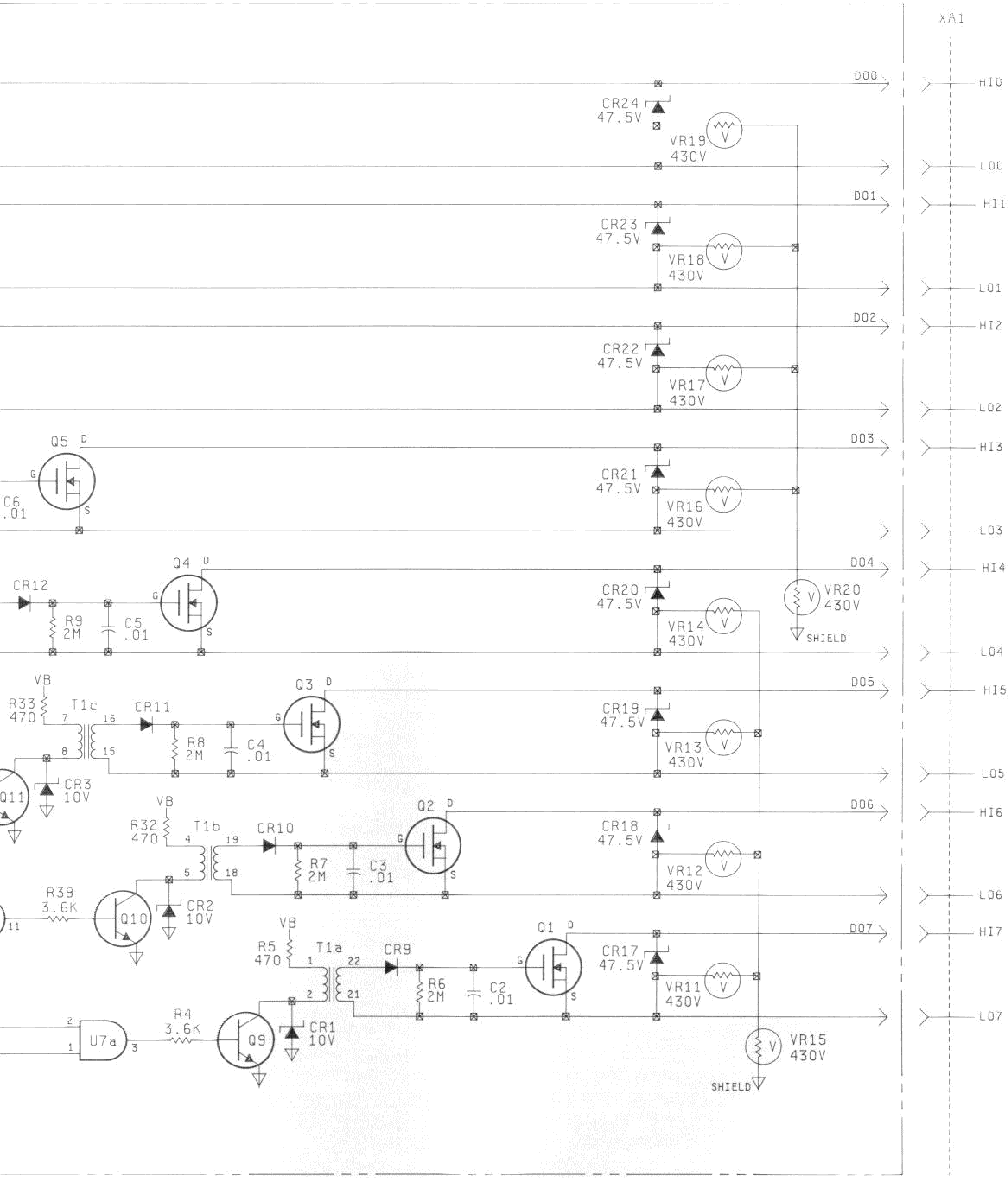
**IC Power Supply Configurations**

| IC # | Type | HP P/N | VB | +5V | GND |
|---|---|---|---|---|---|
| U1 | MC14034 | 1820-2232 | – | 24 | 11,12,14 |
| U2 | MM74C373N | 1820-2215 | – | 20 | 10 |
| U3 | MM74C240N | 1820-2538 | – | 20 | 10 |
| U4 | MM74C244N | 1820-2537 | – | 20 | 10 |
| U5 | MC14049UBCP | 1820-1746 | – | 1,3,5,9,11 | 8 |
| U6 | ICM7555IPA | 1820-2466 | – | 4,8 | 1 |
| U7,U8 | MC14081BCP | 1820-1486 | – | 14 | 7 |
| U11-18 | OPTO ISLR | 1990-0545 | – | 2,8 | 5 |

A1/2 DIGITAL IO 44465-66513




REFERENCE TO INSTRUMENT GROUND
REFERENCE TO LOW OF DIGITAL OUTPUT CHANNEL
VB
R38 470
T2d
CR16
R13 2M
C9 .01
Q8
R45 3.6K
U8a
Q16
CR8 10V
RP1 100K
R37 470
T2c
CR15
R12 2M
C8 .01
Q7
R44 3.6K
U8b
Q15
CR7 10V
R36 470
T2b
CR14
R11 2M
C7 .01
Q6
R43 3.6K
U8c
Q14
CR6 10V
R35 470
T2a
CR13
R10 2M
C6 .01
Q5
R42 3.6K
U8d
Q13
CR5 10V
R34 470
T1d
CR12
R9 2M
C5 .01
Q4
R41 3.6K
U7c
Q12
CR4 10V
R33 470
T1c
CR11
R8 2M
C4 .01
R40 3.6K
U7b
Q11
CR3 10V
R32 470
T1b
CR10
R39 3.6K
U7d
Q10
CR2 10V
R5 470
R4 3.6K
U7a
Q9




44465A 0 13A/2

Figure 3-8-4. Digital I/O Assembly, Output Circuitry

# CHAPTER 4
# MODEL 44461A
# (OPTION 201)
# HP-IB OPTION ASSEMBLY

# CHAPTER 4

# MODEL 44461A (OPTION 201)

# HP-IB OPTION ASSEMBLY

**Engineering Revision Codes (ERCs)**

This chapter applies directly to HP-IB assemblies with an engineering revision code of 2420. See Section VII of this chapter if your assembly has an ERC lower than 2420. If the ERC of your assembly is above 2420, updating information may be on a yellow MANUAL CHANGES supplement (located at the front of the manual).

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## TABLE OF CONTENTS

## CHAPTER 4

## LIST OF TABLES



## LIST OF ILLUSTRATIONS

# SECTION I
# GENERAL INFORMATION

**WARNING**

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## 4-1-1. INTRODUCTION

4-1-2. This chapter is intended for use by qualified service trained personnel only. Other individuals refer to the "HP 3421A Operating, Programming, and Configuration Manual".

4-1-3. The installation and service information of the HP 44461A HP-IB* Assembly is in this chapter. Condensed operating (i.e., programming) information for the service trained individual is also provided. For complete operating information, refer to the "HP 3421A Operating, Programming, and Configuration Manual".

4-1-4. The chapter has eight sections that are assigned as follows:

**Section I - General Information**
This section describes the content of Chapter 4, has a brief description of the HP-IB Assembly and lists the available cable accessories.

**Section II - Installation**
This section explains how to install the assembly in the HP 3421A. Information is also given on general HP-IB interface requirements such as switch settings, cable length, etc.

HP-IB (Hewlett-Packard Interface Bus) is Hewlett-Packard's implementation of the IEEE 488-1978 and ANSI MC1.1.

**Section III - Operation**
This section contains condensed operating instructions for service trained individuals.

**Section IV - Operation Verification**
This section contains the operation verification procedure for the HP-IB Assembly.

**Section V - Adjustments**
This section normally has the adjustment procedures. However, since the HP-IB Assembly has no adjustments, no procedures will be in this section.

**Section VI - Replaceable Parts**
For ease in obtaining part numbers, all the replaceable parts for the HP-IB Assembly are in Chapter 1 (Mainframe Service Information), Section VI of the manual. Ordering information, and all chassis and mechanical parts are also included.

**Section VII - Manual Changes**
This section contains information to update this chapter for use with HP-IB Assembly that have ERC numbers different than shown on the title page of this chapter. It also adapts this chapter to assemblies that are different than what is described in this chapter.

**Section VIII - Service**
This section contains troubleshooting information, theory of operation, and the schematic.

## 4-1-5. OPTION DESCRIPTION

4-1-6. The HP 44461A (Option 201) is an HP-IB interface for the HP 3421A. Since all Model 3421A communication is carried out via HP-IL, this interface serves as an HP-IB to HP-IL converter as well as an HP-IL to HP-IB converter. The HP-IB Assembly operating power is provided by the mainframe and requires less than 1W.

## 4-1-7. PRINTED CIRCUIT BOARD IDENTIFICATION

4-1-8. The HP-IB Board is identified by the board number and the engineering revision code. These two numbers identify the electrical characteristics of the circuit board. The engineering revision code and board part number are listed on the schematic, component locator, and replaceable parts list.

4-1-9. In any service related correspondence, identify the printed circuit board by using the board number followed by the engineering revision code. For example:

44461-66502-2310

would identify a HP-IB option circuit board having an engineering revision code of 2310.

## 4-1-10. BOARD PART NUMBER AND ERC NUMBERS

4-1-11. The HP part number of the printed circuit board is etched on the pc board. It is a ten digit number, separated by a hyphen into two groups of five digits. the first five digits identify the model or assembly number; the last five digits are unique to the assembly.

4-1-12. The ERC number is on a label which is the only one on the pc board that has a four digit number. This four digit code is in the form of YYWW, where YY is the last two digits of the year minus 60, and WW is the week. For example, an ERC of 2310 would identify a change that was made to the assembly in the tenth week of 1983. Refer to Chapter 1, Section I for more information on ERC numbers.

## 4-1-13. ACCESSORIES

4-1-14. The following cable accessories are available for the HP-IB option.

1 Metre HP-IB Cable (HP Part Number 10833A)
2 Metre HP-IB Cable (HP Part Number 10833B)
4 Metre HP-IB Cable (HP Part Number 10833C)
0.5 Metre HP-IB Cable (HP Part Number 10833D)

## 4-1-15. SPECIFICATIONS

4-1-16. There are no specifications for the HP-IB Assembly. However, when operating from the HP 3421A's internal battery, portable operating time is reduced to 6 hours. This assumes that the battery has a full charge when portable operation begins.

# SECTION II
# INSTALLATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 4-2-1. INTRODUCTION

4-2-2. This section explains how to install the HP 44461A HP-IB Assembly in the instrument. Generally, the procedures assumes that the HP-IB assembly is being installed in the instrument the first time. Also included in this section are initial inspection procedures, power requirements, switch settings, and instructions for repackaging and shipment.

**CAUTION**

*Use clean handling techniques and anti-static procedures when handling the option assembly. The HP-IB assembly contains CMOS devices which are susceptible to damage from static discharges.*

## 4-2-3. INITIAL INSPECTION

4-2-4. This option was carefully inspected and tested at the factory. If this option was ordered separately and needs to be installed in the HP 3421A, visually inspect it for physical damage that may have occured during transit. If there is any damage, promptly notify the nearest Hewlett-Packard Sales and Service Office. A listing of these offices is located at the end of this manual. If the shipping carton is damaged or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard Office, and keep the shipping materials for the carrier's inspection. The sales and service office will arrange for repair or replacement of your assembly (at HP's option) without waiting for the claim against the carrier to be settled.

### 4-2-5. POWER REQUIREMENTS

4-2-6. Electrical Power is supplied by the HP 3421A Mainframe.

### 4-2-7. INSTALLATION PROCEDURE

**WARNING**

*Only qualified service trained individuals should remove, install, or reconfigure the option assemblies.*

*LETHAL voltages may be present on multiplexer option assemblies even though the instrument is disconnected from the ac power line. Before doing ANY handling or servicing of the option assemblies, make certain that all external sources of power to the option assemblies have been removed.*

4-2-8. To install the HP-IB assembly, the HP 3421A case must be disassembled. If an option occupies slot 2 of the Model 3421A, it must be removed before the HP-IB option can be installed. If you remove an option, note the orientation and routing of all cables and plugs as they must be reinstalled in the same manner. Use the following procedure to install the HP-IB assembly.

a. Make sure the HP 3421A is turned off and ac power cord is disconnected from the instrument. Also make sure all external sources of power have been removed from the option terminal blocks.

b. Turn the instrument upside down. This is preferably done on top of a protective mat to reduce the possibility of scratching or marring the instrument case. Refer to Figure 4-2-1 and loosen the six screws on the instrument bottom.

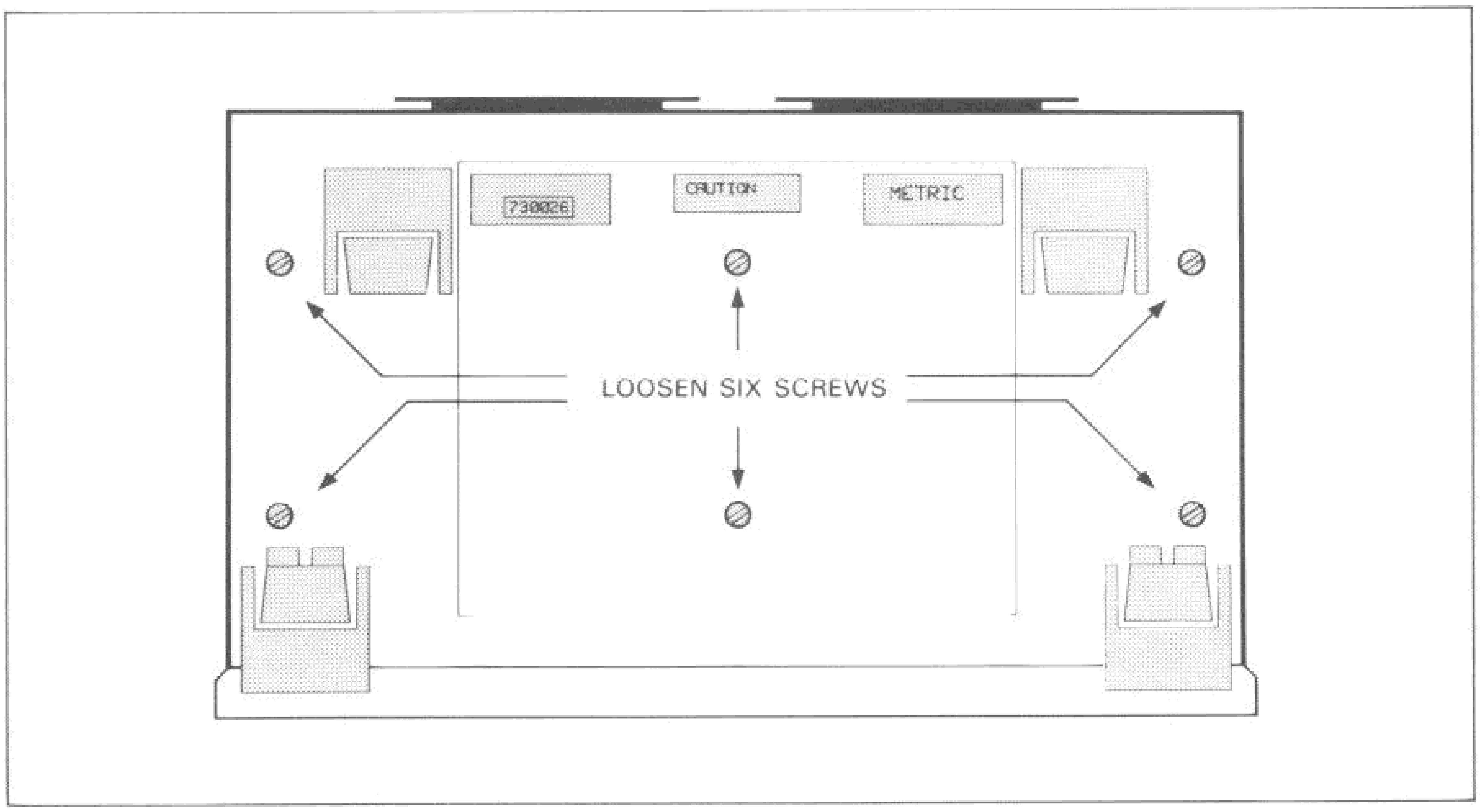



Figure 4-2-1. Loosen Bottom Screws

c. Hold the top cover in place and turn the instrument upright. Then remove the top cover.

d. Refer to Figure 4-2-2 and locate the battery fuse toward the right rear of the instrument. Remove it from its socket. Instead of removing the fuse, you can unplug the red wire from the battery. If this is done, make sure the wire is placed out of the way and away from the battery.

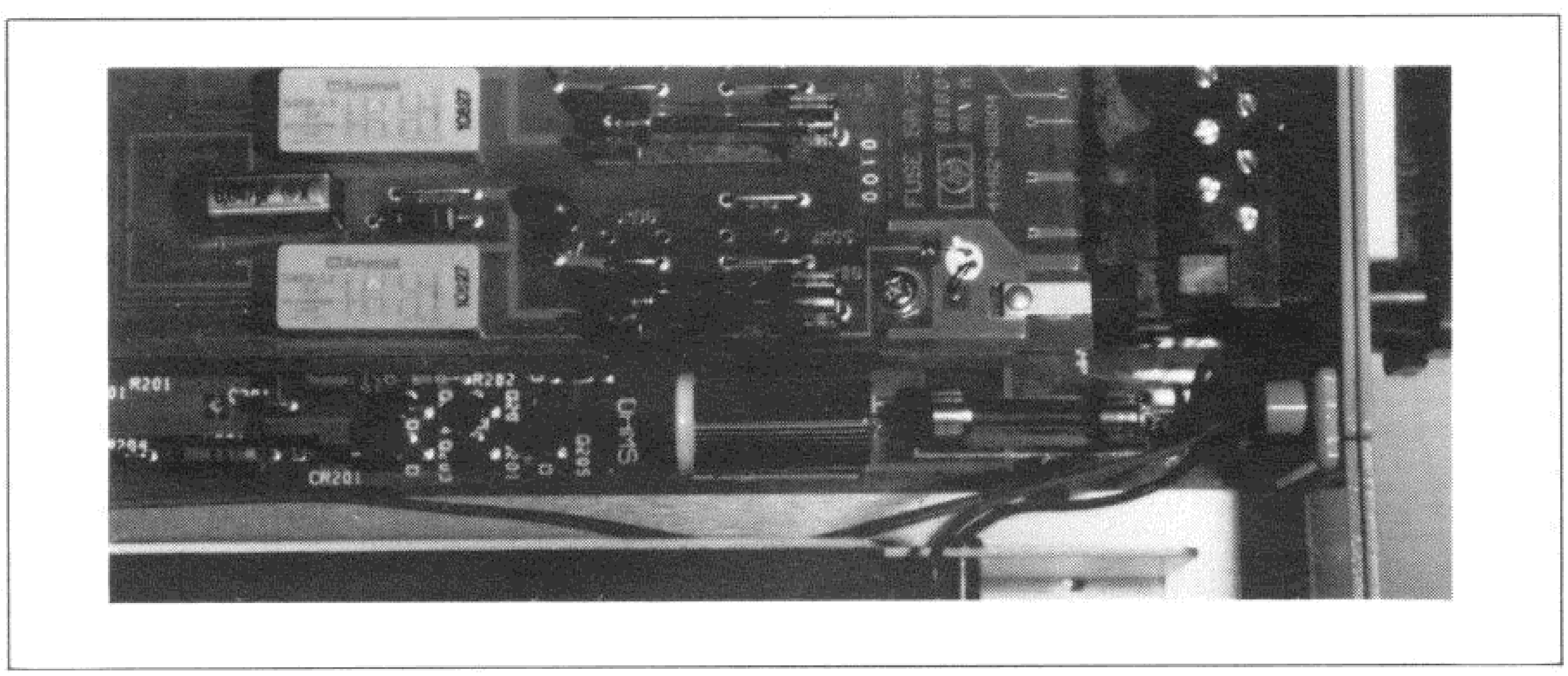


Figure 4-2-2. Remove Main Battery Fuse

e. Remove the black strain relief and grey "WARNING" safety cover form slot 2 as follows:

1. Remove the two screws holding the black strain relief bar.

2. Loosen the two captive screw that hold the grey "WARNING" safety cover.

3. Loosen the two screws holding the terminal block to the option circuit board and then remove the terminal block.

f. If an option is installed in slot 2, refer to Figure 4-2-3. Unplug the ribbon cable connector from the option in slot 2. Lift the connection straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

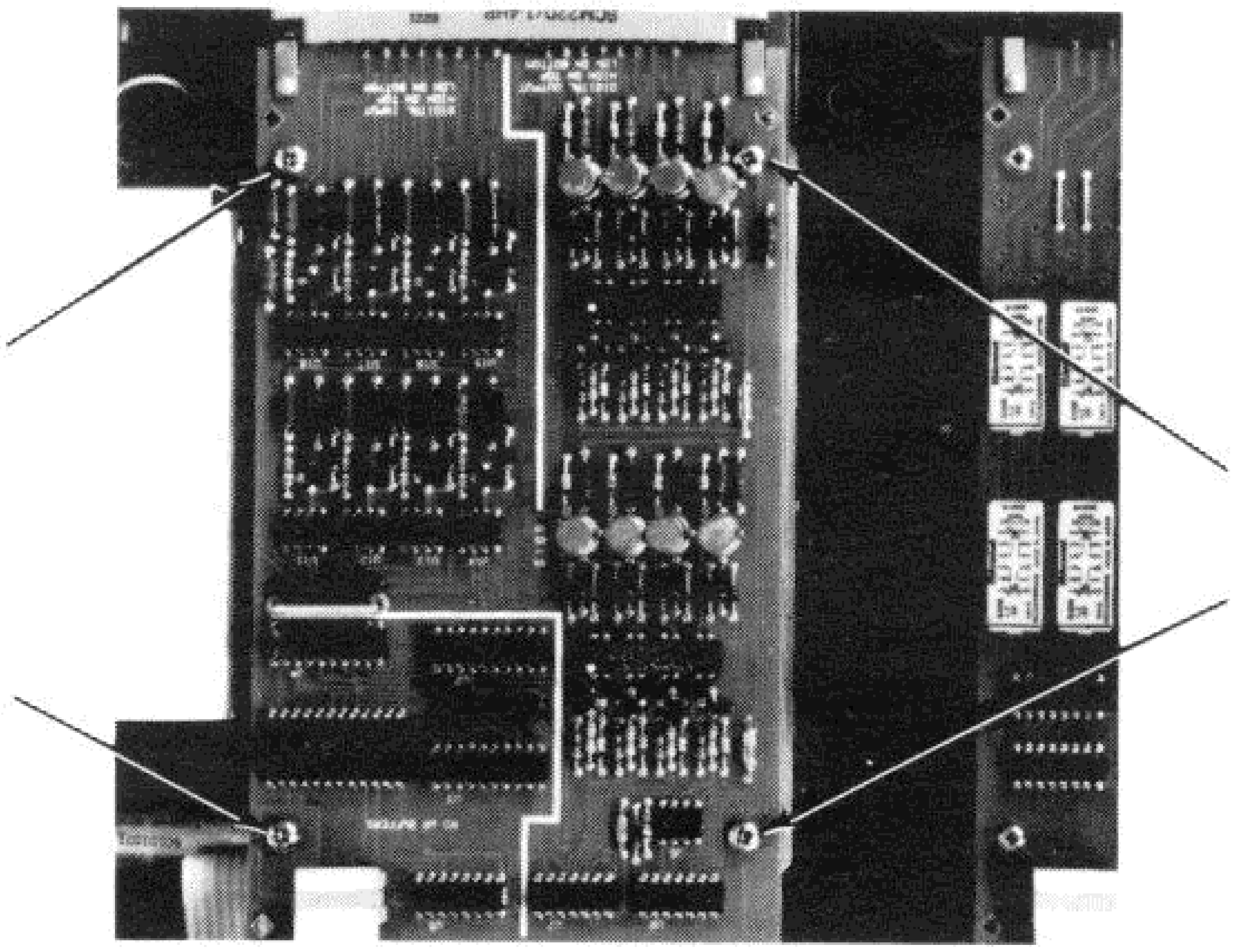


**Figure 4-2-3. Removing the Slot 2 Option**

g. Locate and remove the four screws holding the option in place.

h. If there was previously an HP-IB assembly installed in the HP 3421A, continue with step k. If no HP-IB assembly was previously installed (i.e., you are installing the HP-IB option the first time), remove the metal shield and discard it (see Figure 4-2-4). A new shield with shorter standoffs is supplied with the option.

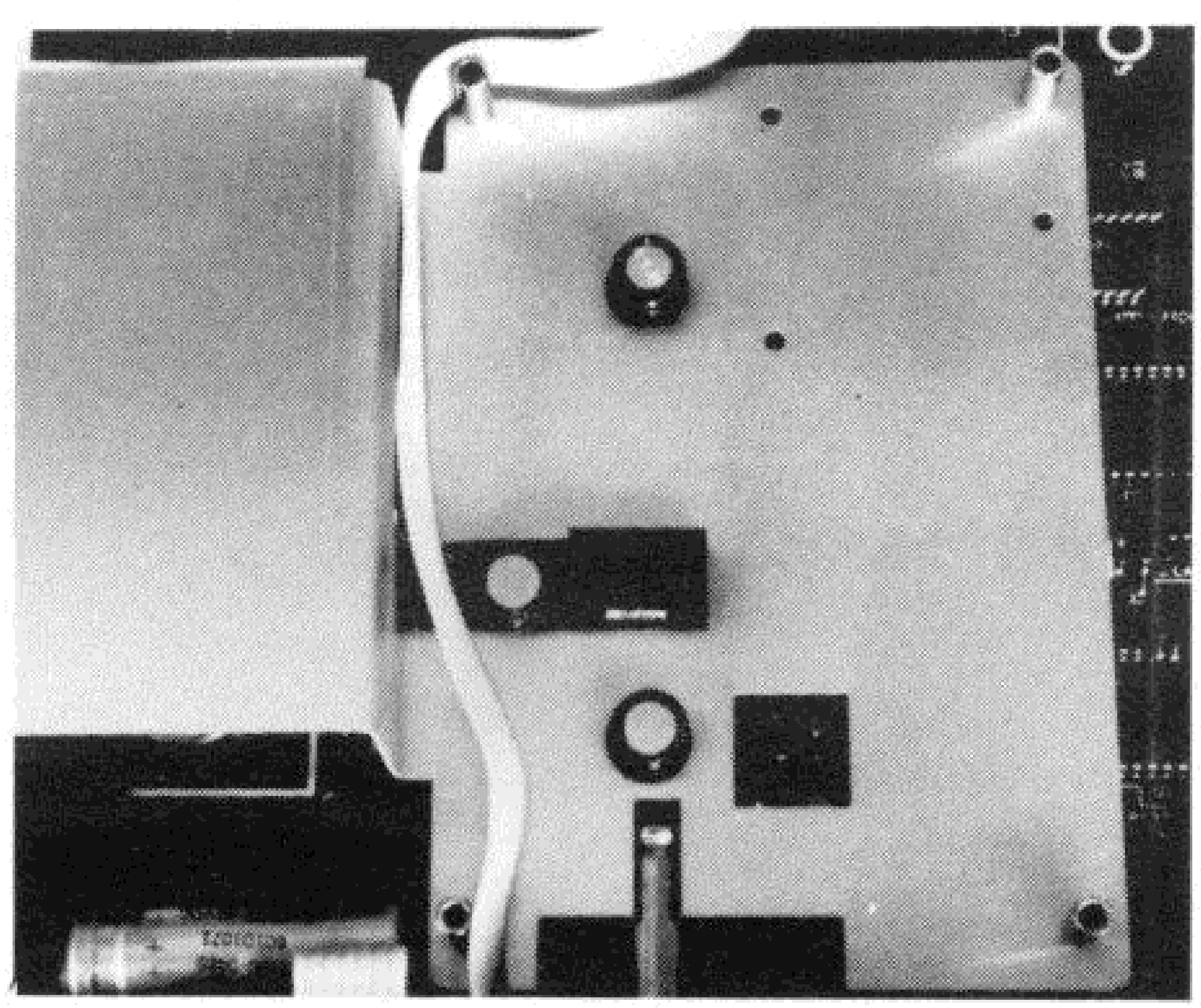


**Figure 4-2-4. Metal Shield**

i. Remove the old back panel with the HP-IL connector. Unplug the HP-IL connector from the motherboard, as shown in Figure 4-2-5.

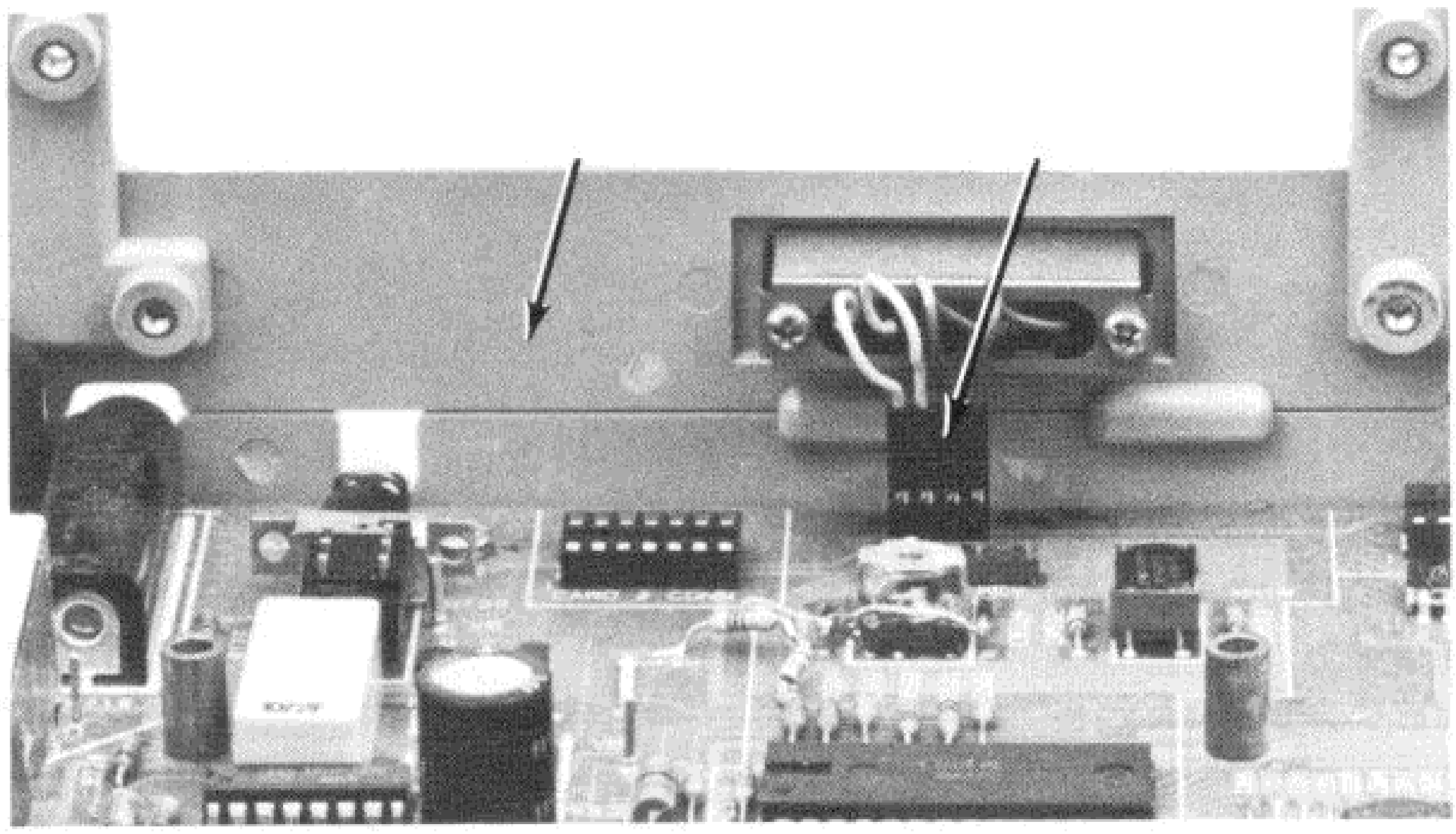


**Figure 4-2-5. HP-IL Back Panel and Connector**

j. Install the new metal shield (short standoffs) in place of the old shield.

k. Refer to Figure 4-2-6 and plug the various cables and wires between the HP-IB option assembly and motherboard as follows:

**WARNING**

*For installation and operating safety, make sure the green-white wire is connected exactly as directed.*

Green-white wire between J802 on the HP-IB board and J702 on the HP 3421A motherboard (HP-IB ground). In early instruments, the wire was soldered to earth ground on the motherboard AC connector (J700).

Connect the 2-wire cable (red and black wires) between J803 on the HP-IB option board and J701 on the HP 3421A motherboard. The red wire is connected to "+" on the HP-IB board and toward the rear of the HP 3421A motherboard.

Connect the 4-wire cable (blue and yellow wires) between J804 on the HP-IB option board and J505 on the motherboard. Make sure the cable is connected to the HP-IB board as shown on the board (i.e., blue wire to BLU and yellow wire to YEL). Also make sure the yellow wire is connected to pin 1 of J505 and the blue wire to pin 4 of J505 on the motherboard.

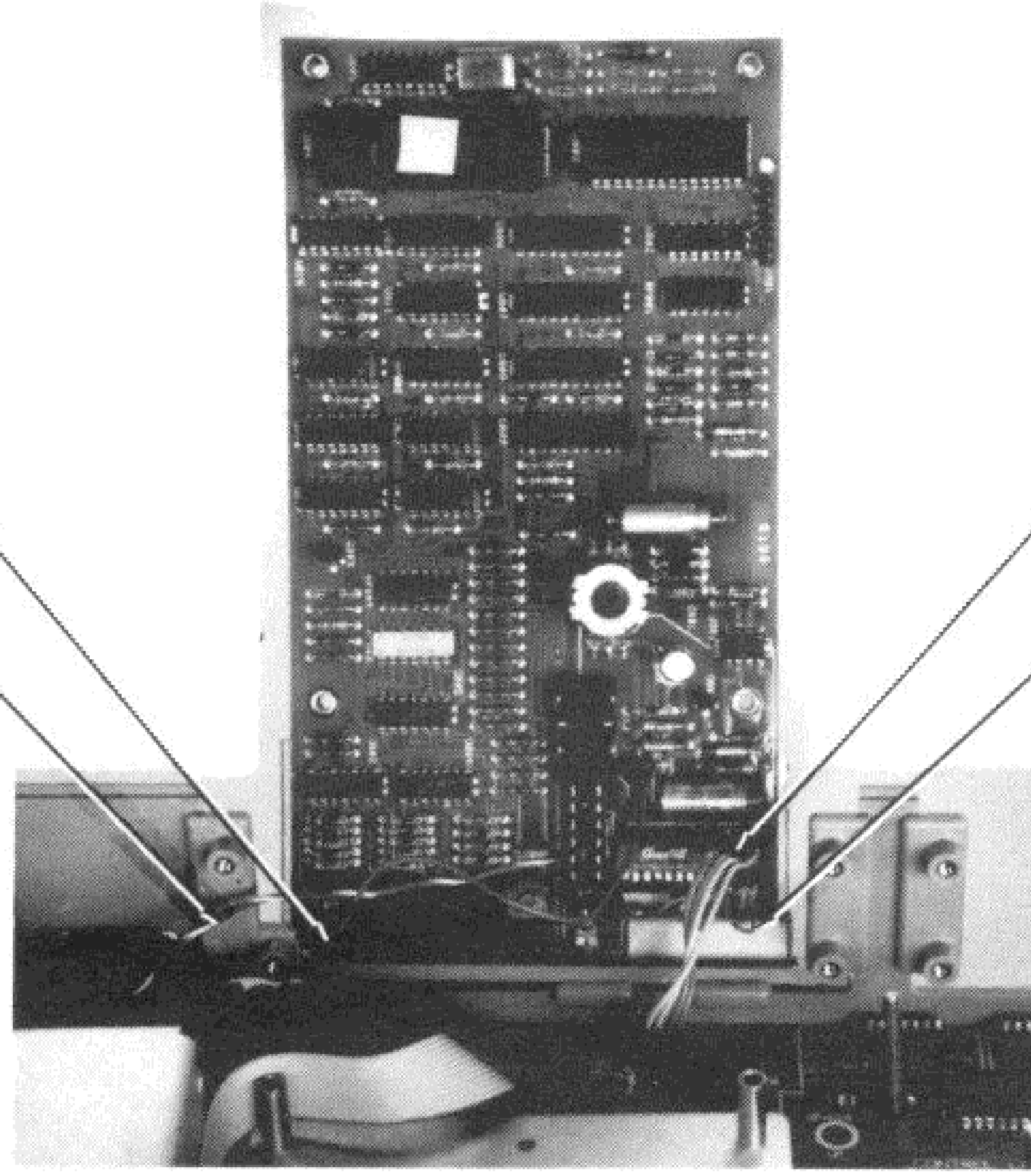


Figure 4-2-6. Connect HP-IB Option Wires/Cables

l. Place the HP-IB option on top of the bottom shield with the component side down.

m. Refer to Figure 4-2-7 and tighten the two screws that secure the HP-IB back panel to the HP 3421A rear panel.


Figure 4-2-7. HP-IB Back Panel

n. Set the slot 2 option in place with the component side up. Then put the four long screws in place. Do not tighten the screws at this time.

o. Plug the appropriate terminal block edge connector onto the slot 2 option.

p. Install the rear panel cover (i.e., the grey "WARNING" cover) for the slot 2 option.

r. Align the slot 2 option so that the strain relief can be screwed into place. Screw the strain relief loosely into place.

s. Tighten the four screws securing the slot 2 and HP-IB option assemblies to the mainframe. Do not overtighten the screws.

t. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 2. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 2 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J100 with the wires oriented as noted on the motherboard.

u. Reinstall the battery fuse or reconnect the red wire to the battery.

v. Locate the six plastic spacers and place them over the six cabinet screws as shown in Figure 4-2-8.

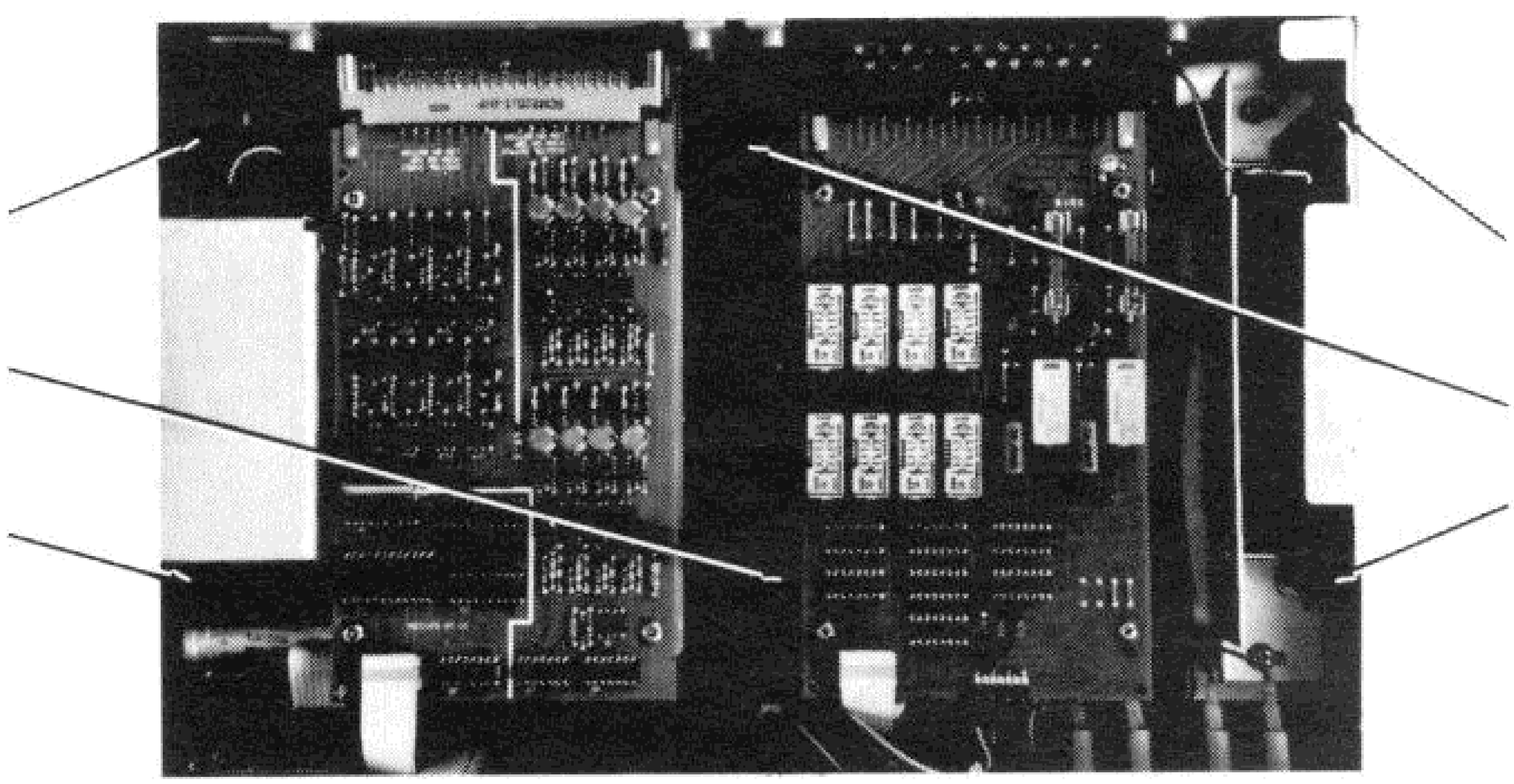


**Figure 4-2-8. Plastic Spacer Placement**

w. Set the instrument on your work bench. Make sure the bale handles on the front feet are collapsed.

x. Align the top cover and lower it in place. If the top cover does not go into place, make sure the front and rear grooves that guide it are properly aligned. If the grooves are aligned, one of the plastic spacers is probably out of alignment. To correct this, alternately move the top cover back and forth (left to right) until the spacers align properly.

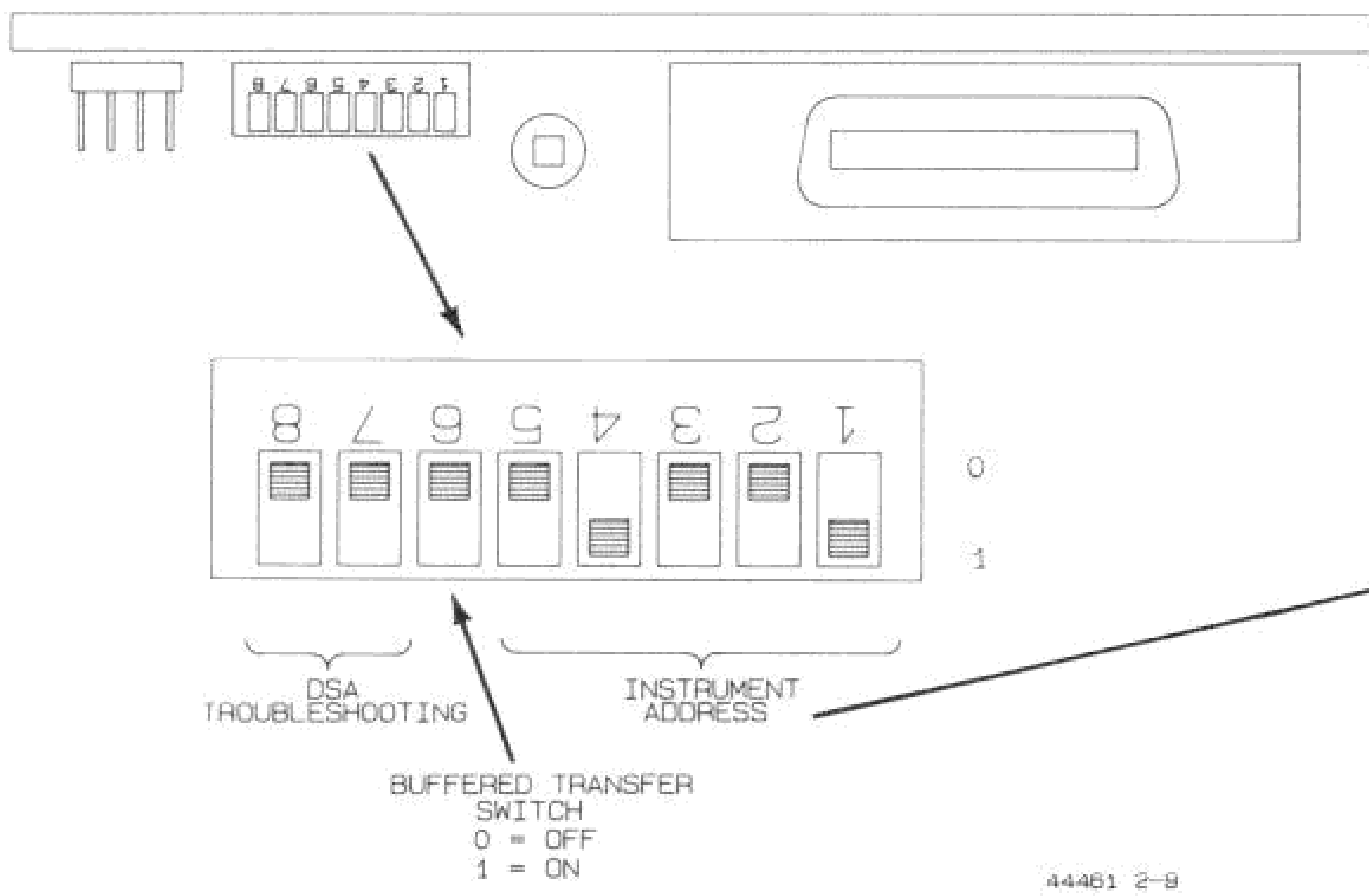
y. Once the top cover is in place, hold the two halves of the case together and turn the instrument upside down. Tighten the six screws.

## 4-2-9. HP-IB OPTION SWITCHES

4-2-10. The HP-IB assembly has an eight segment switch located near the rear panel. These switches are used to set the HP-IB address and to enable/disable buffered transfers. Two of these switches are reserved for the implementation of digital signature analysis. Access to the switches is gained by removing the grey access panel. Note that the two hex nuts on the HP-IB connector must also be removed.

### 4-2-11. HP-IB Address Switches

4-2-12. The HP-IB address is determined by the setting of the five right-most switch segments (as viewed from the rear panel, component side down). At power-on, these switch segments are read and the HP-IB address displayed. Normally, the HP-IB option is preset to address 09 at the factory. However, when the HP 3421A is shipped as part of HP 3056DL system, it will have an address of either 01 or 02. Refer to Figure 4-2-9 for setting the address switches.




| | Address | Switch Segment 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|
| | 00 | 0 | 0 | 0 | 0 | 0 |
| | 01 | 0 | 0 | 0 | 0 | 1 |
| | 02 | 0 | 0 | 0 | 1 | 0 |
| | 03 | 0 | 0 | 0 | 1 | 1 |
| | 04 | 0 | 0 | 1 | 0 | 0 |
| | 05 | 0 | 0 | 1 | 0 | 1 |
| | 06 | 0 | 0 | 1 | 1 | 0 |
| | 07 | 0 | 0 | 1 | 1 | 1 |
| | 08 | 0 | 1 | 0 | 0 | 0 |
| Preset | 09 | 0 | 1 | 0 | 0 | 1 |
| | 10 | 0 | 1 | 0 | 1 | 0 |
| | 11 | 0 | 1 | 0 | 1 | 1 |
| | 12 | 0 | 1 | 1 | 0 | 0 |
| | 13 | 0 | 1 | 1 | 0 | 1 |
| | 14 | 0 | 1 | 1 | 1 | 0 |
| | 15 | 0 | 1 | 1 | 1 | 1 |
| | 16 | 1 | 0 | 0 | 0 | 0 |
| | 17 | 1 | 0 | 0 | 0 | 1 |
| | 18 | 1 | 0 | 0 | 1 | 0 |
| | 19 | 1 | 0 | 0 | 1 | 1 |
| | 20 | 1 | 0 | 1 | 0 | 0 |
| | 21 | 1 | 0 | 1 | 0 | 1 |
| | 22 | 1 | 0 | 1 | 1 | 0 |
| | 23 | 1 | 0 | 1 | 1 | 1 |
| | 24 | 1 | 1 | 0 | 0 | 0 |
| | 25 | 1 | 1 | 0 | 0 | 1 |
| | 26 | 1 | 1 | 0 | 1 | 0 |
| | 27 | 1 | 1 | 0 | 1 | 1 |
| | 28 | 1 | 1 | 1 | 0 | 0 |
| | 29 | 1 | 1 | 1 | 0 | 1 |
| | 30 | 1 | 1 | 1 | 1 | 0 |

**Figure 4-2-9. HP-IB Addresses**

### 4-2-13. Buffered Transfer Enable Switch

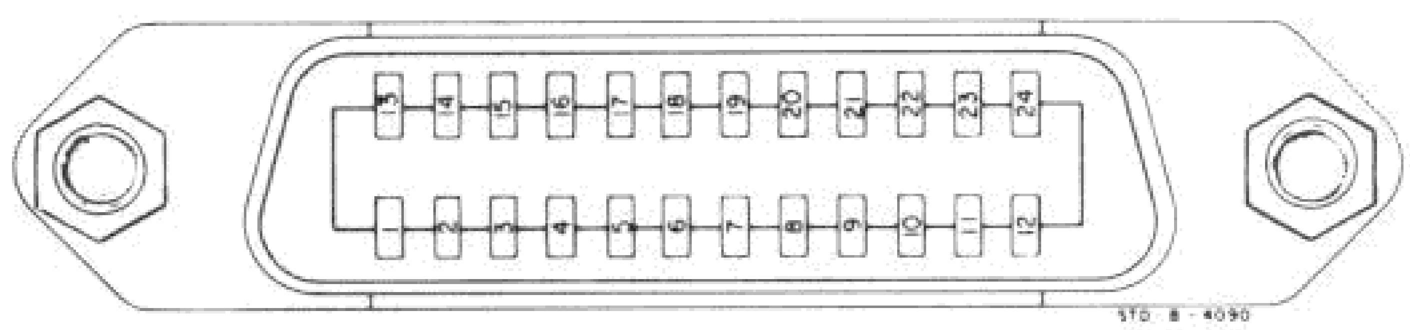
4-2-14. Switch segment 6 is used to enable and disable buffered transfers. The details of buffered transfers are described in the HP 3421A Operating, Programming, and Configuration Manual. As a general rule, this switch segment should be left in the "0" position (up). This position disables buffered transfers.

### 4-2-15. Signature Analysis Switches

4-2-16. Switch segments 7 and 8 are reserved for the implementation of signature analysis. For normal operation, these switches must be in the "0" position (up).

## 4-2-17. HEWLETT-PACKARD INTERFACE BUS (HP-IB)

4-2-18. The Hewlett-Packard Interface Bus (HP-IB) is a carefully defined parallel bus consisting of sixteen signal lines which can interconnect up to fifteen devices. The signal lines are grouped into three sets, according to function. A pictorial view of the HP-IB connector and its pin designations is shown in Figure 4-2-10. A diagram of the interface connections and bus structure is shown in Figure 4-2-11.




| PIN | LINE |
|---|---|
| 1 | DIO1 |
| 2 | DIO2 |
| 3 | DIO3 |
| 4 | DIO4 |
| 13 | DIO5 |
| 14 | DIO6 |
| 15 | DIO7 |
| 16 | DIO8 |
| 5 | EOI |
| 17 | REN |
| 6 | DAV |
| 7 | NRFD |
| 8 | NDAC |
| 9 | IFC |
| 10 | SRQ |
| 11 | ATN |
| 12 | SHIELD—CHASSIS GROUND |
| 18 | P/O TWISTED PAIR WITH PIN 6 |
| 19 | P/O TWISTED PAIR WITH PIN 7 |
| 20 | P/O TWISTED PAIR WITH PIN 8 |
| 21 | P/O TWISTED PAIR WITH PIN 9 |
| 22 | P/O TWISTED PAIR WITH PIN 10 |
| 23 | P/O TWISTED PAIR WITH PIN 11 |
| 24 | ISOLATED DIGITAL GROUND |

THESE PINS ARE INTERNALLY GROUNDED (pins 18–24)

**CAUTION**

*The 3421A contains metric threaded HP-IB cable mounting studs as opposed to English threads. Metric threaded -hp- 10631A, B, or C HP-IB cable lockscrews must be used to secure the cable to the instrument. Identification of the two types of mounting studs and lockscrews is made by their color. English threaded fasteners are colored silver and metric threaded fasteners are colored black. DO NOT mate silver and black fasteners to each other or the threads of either or both will be destroyed. Metric threaded HP-IB cable hardware illustrations and part numbers follow.*

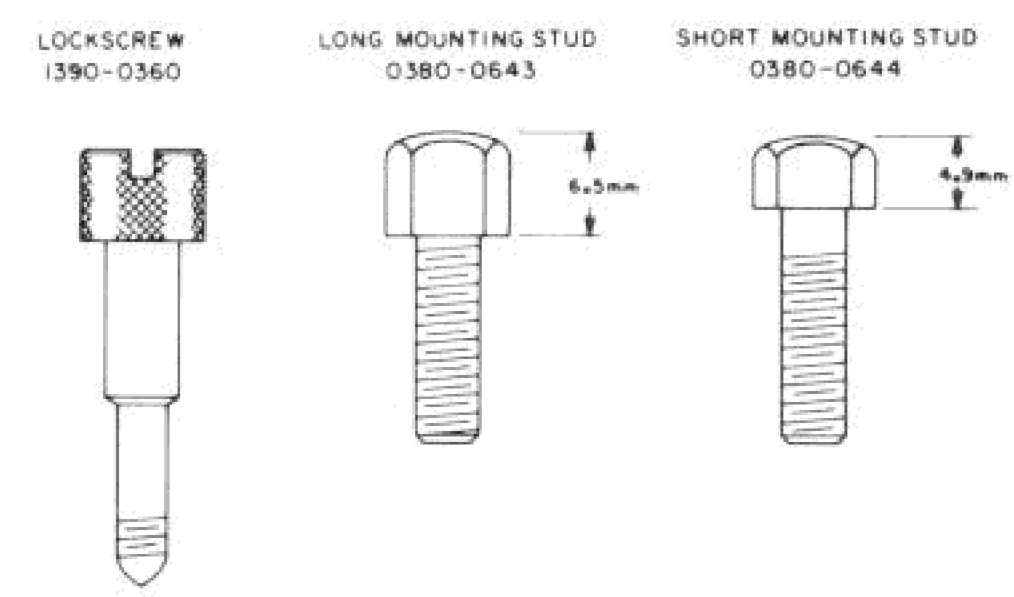



**Figure 4-2-10. HP-IB Connector**

### 4-2-19. Interface Cable Length

4-2-20. The maximum accumulative length of HP-IB cables in any system must not exceed 2 metres of cable per device or 20 metres total, whichever is less.

## 4-2-21. PACKAGING FOR SHIPMENT

4-2-22. Do not return the HP-IB option assembly, or any other option assembly, separately. Return the entire instrument. The exception to this would be if an assembly was ordered and received with obvious damage. When returning the HP 3421A to Hewlett-Packard for service, attach a tag to the instrument identifying the owner and indicating the service to be performed. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number.

4-2-23. Place the instrument in its original container with appropriate packing material and seal the carton with strong tape or metal bands. If the original container is not available, one can be purchased from your local HP Sales and Service Office.

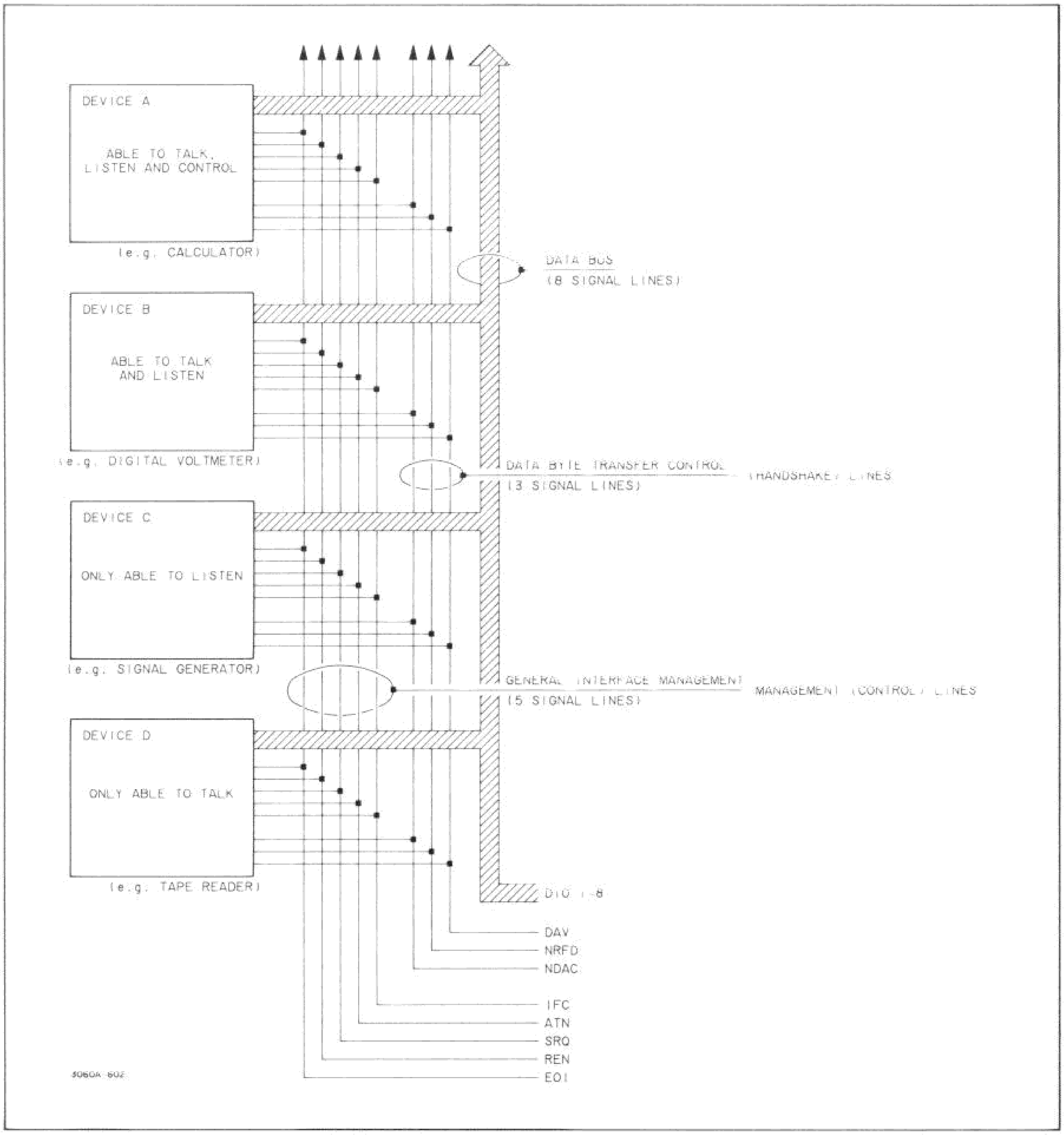



**Figure 4-2-11. Interface Connections and Bus Structure**

# SECTION III
# OPERATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 4-3-1. INTRODUCTION

4-3-2. This section contains operating instructions for the HP-IB interface. For more detailed instructions, refer to the HP 3421A Operating, Programming, and Configuration Manual. The examples in this section assume that an HP-85 computer is used as the system controller.

### 4-3-3. Rear Panel Features

4-3-4. Figure 4-3-1 shows a portion of the HP 3421A rear panel. Note the location of the HP-IB connector, HP-IL connector, and the HP-IB/HP-IL switch. The HP-IB/HP-IL switch must be "IN" to use HP-IB and "OUT" to use HP-IL. It is impossible to use both HP-IB and HP-IL interfaces simultaneously. All examples in this section assume that the switch is set for HP-IB.

### 4-3-5. Internal Battery Operation

**NOTE**

*On older HP 3421A's with serial numbers 2338A03052 and below or A1 Assemblies with an ERC of 2334 and below, the display turns off when the Model 3421A goes into the low power state.*

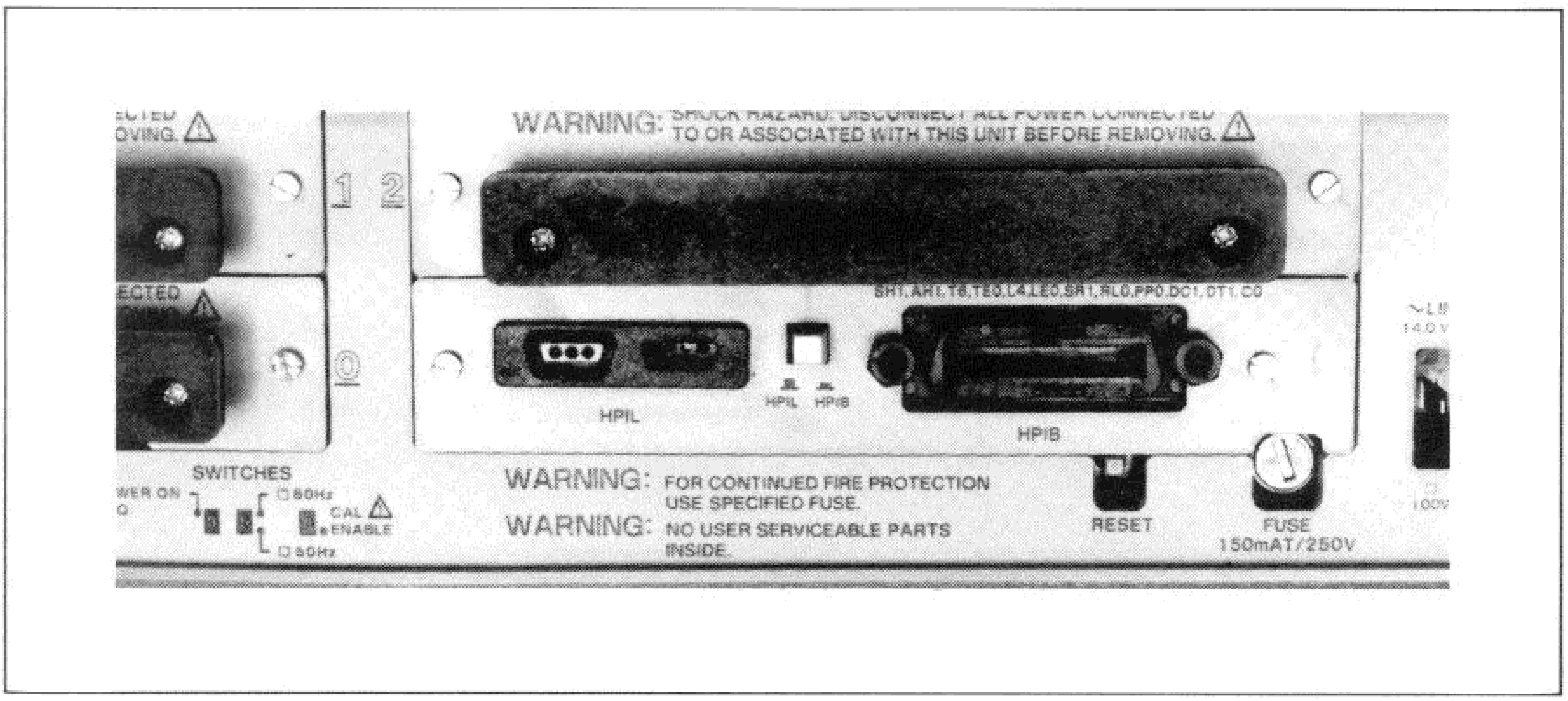



**Figure 4-3-1. HP 3421A HP-IB Rear Panel**

4-3-6. The instrument can be operated from its internal battery up to 12 hours when HP-IL is the interface standard or for six hours if HP-IB is the standard, assuming a fully charged battery before portable operation. If the battery is low (<5.8V) when the Model 3421A is turned on, the instrument displays ERROR 27 and then goes into a power down state (HP 3421A is inoperative) in approximately three seconds. If the battery goes below 5.8V during operation, the ERROR indicator turns on and the instrument goes into the power down state in approximately three minutes, after detecting the low battery. During the power down state, the instrument is completely inoperative, except for the display. If the power down state is enabled at turn on, the power indicator and ERROR 27 remain displayed. If the state is enabled during instrument operation, both the power and error indicators, and the previously closed channels will remain displayed. The battery is charged automatically when ac power is connected to the HP 3421A. A discharged battery that is between 1V and 5.8V can take up to 16 hours to fully charge with the front panel switch off. When the switch is on, it takes about 21 hours if the Model 3421A has HP-IL and longer if equipped with HP-IB. A fully discharged battery (<1V) can take up to 48 hours to charge.

## 4-3-7. ADDRESSING

### 4-3-8. HP-IB Addressing

4-3-9. The instrument HP-IB address is determined by switch settings on the HP-IB option assembly (see Section II). The factory preset address is 09. In the examples given in this section, the instrument will be at address 709. This refers to a computer interface select code of "7" and an instrument HP-IB address of "09".

### 4-3-10. HP-IL Addressing

4-3-11. When the HP-IL interface is being used, the system computer automatically assigns an address to each device. Addresses are assigned sequentially around the loop in the direction of information flow. The address set by the HP-IB address switches is ignored. Refer to the HP 3421A Operating, Programming, and Configuration Manual for more addressing information and examples using the HP-IL interface.

## 4-3-12. COMMANDS

4-3-13. Commands instruct the HP 3421A to perform some specified measurement or task. Table 4-3-1 describes the HP 3421A standard commands. These commands set up the HP 3421A and cause it to complete a measurement task. Advanced commands are more flexible, but they do not perform a complete measurement task. Advanced Commands are described in the Operating, Programming, and Configuration Manual.

**Table 4-3-1. HP 3421A Standard Commands**

| | |
|---|---|
| **DCV[x,y,...z]** | DC Volts. Sets the voltmeter to DCV (F1), Autorange on (RA1), Autozero on (Z1), and 5 ½ digit resolution (N5). If no channel list is sent, the channel list is not changed but software single trigger (T2) is executed. If a channel list is sent, they are loaded in the order received, then a reading is made from each channel in sequence and stored (T3). DCV always opens the last channel before closing the next channel in the list. It exits with the last channel in the list closed. If no channel list was sent, DCV exits with the channels in the same state they were in prior to the command. When the HP 3421A is addressed to talk, all readings will be sent in the sequence they were taken. |
| **ACV[x,y,...z]** | Same as DCV but for AC Volts (F2) and 4 ½ digit (N4) resolution. |
| **TWO[x,y,...z]** | Same as for DCV but for 2-wire ohms measurements (f3). |
| **FWO[x,y,...z]** | Same as for DCV except for 4-wire ohms (F4) measurements. Channels are automatically paired with x + 10, y + 10,... z + 10 unless x,y,...z are between 20 and 29 in which case they are paired with x-20,y-20,...z-20. Channel pairs are closed simultaneously. |
| **TEM[x,y,...z]** | Same as for DCV except does a software compensated temperature measurement (F6) for a T-type thermocouple. Results are returned in degrees C. |
| **REF[x]** | Measures the reference junction temperature (F5) on the 44462A (option 020) assembly where channel x is located. If x is not sent, then it defaults to the assembly where a multiplexer channel is closed. If no multiplexer channel is closed, then it defaults to the 44462A assembly in the lowest numbered slot. Result is returned in degrees C. |
| **FRQ[x,y,...z]** | Measures frequency (F7) with a 1 second gate time (G0) and 5 ½ digit resolution. Otherwise the same as DCV. |
| **TOT[x]** | Totalizes events up to a maximum count of 65,535. If channel x is sent, the HP 3421A will open all other channels, close x, clear the counter and begin totalizing. If x is not sent, then the counter will clear and begin totalizing without changing channels. If the HP 3421A is addressed to talk, it will send the current subtotal without disrupting the counter. |
| **CLS < x >** | Close single channel x. The HP 3421A identifies the type of channel at address x and if x is:<br>an actuator - closes channel x<br>a digital output bit - closes (low impedance) switch x.<br>a Multiplexer - opens all other multiplexer relays and closes x. |
| **CLP < x >** | Closes a pair of channels. The HP 3421A will open all multiplexer channels, and then close channels x and x + 10. If x ≥ 20, then it closes x and x-20. If either x or its pair is not a multiplexer channel, then no channels are closed or opened and an error is generated. |
| **OPN < x >** | Open channel(s). If x is not sent, then the OPN command will open all channels - digital output bits, multiplexer and actuator relays. If x is sent, the HP 3421A determines the type of channel and if x is:<br>an Actuator - opens the relay<br>a Digital Output Bit - clears bit x (high impedance).<br>A Multiplexer - opens the relay. This includes the channels closed by the UC command. If x was closed as a pair, then its pair will be opened also. |
| **RED < i >** | Reads the digital input byte from slot i and replies with a decimal number from 0 to 255. This decimal number represents the sum of the values of the bits that were set. |
| **WRT < i[ab]c >** | Write the decimal value [ab]c to slot i. The value [ab]c ≤ 255. If a and/or b is not sent, then the HP 3421A assumes leading zero's. |
| **BIT < x[,y,...x] >** | Reads the digital input bits(up to 30 in the bit or channel list) and sends + 0.000E + 0 if the bit is low or + 1.000E + 0 if the bit is high. |

4-3-14. Standard commands are convenient to ease the task of programming. All of the examples in this section use standard commands.

## 4-3-15. SENDING INSTRUCTIONS TO THE HP 3421A

4-3-16. Decide what task or measurement you want the instrument to perform and determine the appropriate command. For example, to make a DC voltage measurement, use the DCV command. To make temperature measurements (using T-Type thermocouples), use the TEM command.

4-3-17. Determine the channel from which the measurement is to be made. If the DC voltage measurement is to made from channel 15, execute the command DCV15. The following message would be executed from the computer:

OUTPUT 709 ; "DCV15"

4-3-18. If the same type of measurement is to be made from several channels, a channel list can be used to specify those channels. For example, if T-Type thermocouples are connected to channels 2 through 8 and channel 14, the following command will cause one temperature measurement to be made from each channel:

OUTPUT 709 ; "TEM2-8,14"

4-3-19. The eight temperature measurements will be stored in the instrument's internal memory. Channel 2 will be measured and stored first. Next, channel 3 will be measured and stored. This pattern will continue until channel 14 is stored. A maximum of thirty readings can be stored in this manner. Paragraph 4-3-23 shows how to get the readings out of internal memory.

### 4-3-20. Channel List

4-3-21. The series of channels specified in the channel list must adhere to the following rules:

a. The mnemonic determines which type of channel can be loaded into the channel list. In other words, the channel list can be loaded with multiplexer channels (not actuator or digital) by the DCV, ACV, TWO, FWO, TEM, FRQ, LS, or LP commands. It can be loaded with actuator channels with the CLS and CLP commands. The channel list can be loaded with digital channels with the BIT command.

b. Channel addresses are separated by a comma. However, a dash may be used to signify a contiguous set of channels.

c. No more than 30 channels are accepted into the channel list. Legal channel numbers are 0 through 29.

d. Leading zeros are ignored. Example: DCV000019 means the same as DCV19.

e. All syntax following a decimal point is ignored except for commas, dash, semicolon, colon, Carriage Return, or Line Feed. In other words, DCV2.3 is interpreted as DCV2. Exponents are not allowed and cause a syntax error.

f. All lower case letters are interpreted as upper case. Blanks and plus signs ( + ) are ignored. For example, Dc V +21 is interpreted as DCV21.

g. Terminators are required after any command (Standard or Advanced) that specifies either a channel or a decimal value, when that command is to be followed by another command. For example, OUTPUT 709; "M1;T0". Valid terminators are a colon (:), a semicolon (;), a Carriage Return or a Line Feed; but not a comma (,).

4-3-22. Refer to the HP 3421A Operating, Programming, and Configuration Manual for more information on programming and channel lists.

## 4-3-23. RECEIVING DATA FROM THE HP 3421A

4-3-24. Previously it was explained how to instruct the HP 3421A to take a single DC voltage reading from channel 15. The following program shows that same command and how to get the reading back to the computer.

```
10 OUTPUT 709; "DCV15" ! FROM PARAGRAPH 4-3-17
20 ENTER 709; A
30 DISP A
40 END
```

4-3-25. The HP 3421A is addressed to talk by the ENTER 709 command. The measured voltage is returned to the computer and stored in variable A. Line 30 instructs the computer to display the value of the reading.

4-3-26. Another example was previously given for taking temperature measurements from channels 2 through 8 and channel 14. To read back those measurements, use a variable for each measurement or set up an array. The two sample programs that follow show how these two methods can be done.

```
10 OUTPUT 709 ;"TEM2-8,14"
20 ENTER 709 ;A,B,C,D,E,F,G,H
30 DISP A,B,C,D,E,F,G,H
40 END
```

or

```
10 DIM A(8)
20 OUTPUT 709 ;"TEM2-8,14"
30 FOR I=1 TO 8
40 ENTER 709 ;A(I)
50 DISP A(I)
60 NEXT I
70 END
```

4-3-27. In the first example, a separate variable is used to store each reading. The second example used an array to store the measurements.

### 4-3-28. Output Format

4-3-29. Measurement data is sent by the HP 3421A as 13 bytes in the following format (5 ½ digit mode):

Measurements: ± d.dddddE ± d cr lf
Error: − 8.88888E − 8 cr lf
Overload: + 9.99999E + 9 cr lf

Digital data is sent as:

Digital Data: ddd cr lf (where $0 \leq ddd \leq 255$ decimal)
Digital Error: 888 cr lf

The character "d" represents a single digit. Carriage Return is shown as "cr" and Line Feed is shown as "lf".

## 4-3-30. HP 3421A RESPONSE TO HP-IB INTERFACE MESSAGES

4-3-31. The following paragraphs deal with HP-IB interface commands and how the instrument responds to them. Refer to the computer's I/O Programming Guide for specific information on syntax and the actions taken by the interface when sending the message.

### 4-3-32. HP 3421A Bus Capabilities

4-3-33. The instrument interfaces to the HP-IB as defined by the IEEE Standard 488-1978. The HP-IB functional capabilities that are implemented are listed in Table 4-3-2.

**Table 4-3-2. HP 3421A Bus Capabilities**

| Mnemonic | Description |
|---|---|
| SH1 | Source Handshake capabilities. |
| AH1 | Acceptor Handshake capabilities. |
| T6 | Basic Talker, with Serial Poll, no Talk Only, and unaddressed to Talk when Listen Address received. |
| TE0 | No Extended Talker |
| LE0 | No extended Listener. |
| L4 | Basic Listener, unaddressed to Listen when Talk Address received. |
| SR1 | Complete Service Request capability. |
| RL0 | Remote only capability. |
| PP0 | No Parallel Poll capability. |
| DC1 | Complete Device Clear capability. |
| DT1 | Complete Device Trigger capability. |
| C0 | No Controller capability. |

### 4-3-34. Clear

4-3-35. Upon receiving the Interface Clear or Selective Device Clear message, the instrument goes through its power-on/reset routine. This causes the following events to take place:

a. Self Test

b. Opens all multiplexer and actuator channels.

c. Clears all bits of the digital output ports (high impedance state).

d. Internal voltmeter set to: DC Volts, autorange on, autozero on, 5 ½ digit resolution, internal trigger on.

e. Counter set to 1 second gate time.

f. HP-IL address is not changed.

g. Checks rear panel switches (50/60 Hz, Power-on SRQ, etc.)

h. Channel list set to all available multiplexer channels.

i. Request Service (SRQ) if self test failed.

j. Reading Storage is cleared.

#### 4-3-36. Local, Local Lockout, Remote

4-3-37. The HP 3421A does not respond to these commands. This is because the HP 3421A has no front panel and therefore must be controlled by a computer through an interface. The HP 3421A is always in REMOTE mode.

#### 4-3-38. Require Service (SRQ)

4-3-39. The Require Service Message is independent of all other HP-IB activity and is sent on a single line. There are many conditions which can be programmed to cause an SRQ interrupt to occur. The following is a list of those conditions.

a. **Power-on/Reset.** The HP 3421A interrupts the computer when its power is turned on, an Interface Clear or Selective Device Clear message, or it is reset (RS command). The Model 3421A rear panel switch segment 3 must be set to the up position for an interrupt to occur for these conditions.

b. **Data Ready.** The HP 3421A will interrupt the computer after each completed measurement or, if a channel list is used, the interrupt will occur after all readings are taken.

c. **Self Test Error.** If any of the eight self tests fail, an interrupt will occur. This condition is not maskable.

d. **Event Occurred.** The HP 3421A can monitor the digital input ports and if a specified bit goes either high or low, or a specified 8-bit word occurs, it will interrupt the controller.

e. **Low Battery.** If the HP 3421A is being powered by its internal battery, it will generate an interrupt when the battery voltage drops too low. This condition is not maskable.

f. **Abnormal Condition.** Abnormal conditions include:

1. Hardware error
2. Calibration error
3. Syntax error
4. Can't execute a given command
5. Low battery
6. Self Test failed

4-3-40. Some interrupt conditions are described as not maskable. This simply means that if any of these conditions occur, the SRQ line goes true without programming the HP 3421A to generate the interrupt. The HP 3421A must be programmed for the remaining conditions to cause the SRQ line to go true. The computer, of course, must be programmed to respond to the SRQ interrupt. For more information on these conditions, refer to the HP 3421A Operating, Programming, and Configuration Manual.

**4-3-41. Status Register and Status Byte.** The Status Register is updated as events occur. Six of the Status Register bits represent each of the conditions listed in paragraph 4-3-39. It is possible for one or more of the conditions (bits) to be true in the HP 3421A at any time. However, the SRQ interrupt will only occur when one of the not-maskable conditions is true, or the SRQ mask has been set and the respective condition is true. When either of these conditions is met, bit 6 in the Status Register will set, and the SRQ interrupt will be sent to the computer. The computer must be programmed to respond to the interrupt.

4-3-42. The Status Byte is an 8-bit byte that is sent from the HP 3421A to the computer in response to a Serial Poll (SPOLL). The Status Byte is a bit for bit replica of the Status Register and can be used to determine the current status of the HP 3421A. See Figure 4-3-2.

| N/A (always zero) | Require Service (no mask) | Abnormal Condition | Low Batt. (no mask) | Event Occurred | Self Test Error (no mask) | Power On Reset (switch mask only) | Data Ready |
|---|---|---|---|---|---|---|---|
| Bit 7 | Bit 6 (64) | Bit 5 (32) | Bit 4 (16) | Bit 3 (8) | Bit 2 (4) | Bit 1 (2) | Bit 0 (1) |

**Figure 4-3-2. Status Register**

**4-3-43. Status Bit.** The Status Bit is used in response to a parallel poll. The HP 3421A, however, does not implement the parallel poll function.

### 4-3-44. Programming the SRQ Mask

4-3-45. To set the SRQ Mask, refer to Figure 4-3-2 and identify the conditions where you want the instrument to generate an SRQ interrupt (e.g., Data Ready, Abnormal Condition, or Event Occurred). Add together the decimal values for all conditions (bits). Then, output the "M" command followed by the summed decimal value. For example, to set the SRQ mask for Event Occurred, execute:

```
OUTPUT 709 ; "M8"
```

To set the SRQ mask for either Event Occurred or Data Ready, execute:

```
OUTPUT 709 ; "M9"
```

**NOTE**

*When doing interrupt programming, especially with the digital monitor commands (MN, MH, ML, and DT), the end-of-line sequence should be suppressed. With most HP desktop computers, this is done with the OUTPUT USING "#,K" command. The last character in the command string should be either a colon (:), a semicolon (;), a Carriage Return, or a Line Feed.*

*If you are using the HP-IB interface and want to interrupt on Event Occurred, the HP 3421A must be set to UNLISTEN mode before it can interrupt the computer. With most HP desktop computers this is done with the SEND 7, UNL command. This is not necessary when using the HP-IL interface.*

#### 4-3-46. Serial Poll (SPOLL)

4-3-47. Serial Poll allows you to determine the current status of the HP 3421A. When the HP 3421A receives the Serial Poll message it returns its Status Byte to the computer (from the Status Register). The decimal value returned is the sum of the individual values of the bits that are set in the Status Register. For example, if bits 6 and 1 are set (Power-On Reset SRQ), the value returned is 66 (64 + 2 = 66). Refer to Figure 4-3-2.

#### 4-3-48. Trigger

4-3-49. The Trigger command will cause the HP 3421A to take one or more readings depending upon the HP 3421A trigger mode that is asserted. For example, if internal trigger is asserted (T1), Trigger will cause it to take one reading. If either scan trigger (T3) or hold/scan enable (T0) is asserted, then Trigger will cause the HP 3421A to make measurements according to the channel list.

# SECTION IV
# OPERATION VERIFICATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 4-4-1. INTRODUCTION

4-4-2. This section contains the operational verification procedure for the HP-IB assembly. This procedure provides a high confidence level that you have properly installed the HP-IB assembly, and that it is operating properly.

## 4-4-3. EQUIPMENT REQUIRED

4-4-4. This procedure requires an HP-85 computer equipped with HP-IB and the I/O ROM.

## 4-4-5. OPERATION TEST PROCEDURE

4-4-6. To run this test, do the following:

a. With the computer and instrument both "OFF", connect the HP-IB I/O cables.

b. Press the instrument front panel switch "ON".

c. Turn the computer power switch "ON".

d. Execute the following program line. This should cause the instrument to perform self test. Watch the front panel display to make sure there are no self test errors. See the Operating, Programming, and Configuration Manual for a discussion of self test. If self test fails, it is most likely a mainframe problem since none of the HP-IB circuitry is tested.

```
OUTPUT 709 ; "RS"
```

e. Make sure the rear panel Power-on SRQ switch segment is in the "UP" position.

f. Cycle the instrument front panel switch "OFF" and then "ON".

g. Run the following program:

```
10 OUTPUT 901 ; "SR"
20 ENTER 901 ; A
30 DISP A
40 END
```

h. The computer should be displaying 66. This corresponds to bit 6 (Require Service) and bit 1 (Power-on Reset) being set in the first status register. Bit 6 is equivalent to decimal 64 and bit 1 is equivalent to decimal 2. See Figure 4-4-1.

| N/A (always zero) | Require Service (no mask) | Abnormal Condition | Low Batt. (no mask) | Event Occurred | Self Test Error (no mask) | Power On Reset (switch mask only) | Data Ready |
|---|---|---|---|---|---|---|---|
| Bit 7 - | Bit 6 (64) | Bit 5 (32) | Bit 4 (16) | Bit 3 (8) | Bit 2 (4) | Bit 1 (2) | Bit 0 (1) |

**Figure 4-4-1. Status Register**

i. If the computer is displaying a decimal value of 66, the HP-IB assembly is properly installed and can be assumed to be operational. If the computer is not displaying 66, decode the number it is displaying and refer to the mainframe service manual for troubleshooting.

# SECTION V
# ADJUSTMENTS

4-5-1. This section normally contains instrument adjustment procedures. Since the Model 44461A HP-IB Option Assembly has no adjustment procedures, there is no adjustment information in this section. Information about the HP-IB switches can be found in Section II of this chapter.

# SECTION VI
# REPLACEABLE PARTS

4-6-1. This section normally contains information for ordering replaceable parts. However, the replaceable parts for the Model 44461A HP-IB Option Assembly are included in Chapter 1 (Mainframe Service Information), Section VI of the manual.

# SECTION VII
# MANUAL CHANGES

## 4-7-1. INTRODUCTION

4-7-2. This section has information to adapt this manuals to older HP-IB assemblies that have no ERC (Engineering Revision Codes) number or a number lower than shown on the title page.

### 4-7-3. Engineering Revision Code (ERC)

4-7-4. The engineering revision code (ERC) is changed whenever a change is made to an assembly. The change could be a printed circuit board revision, a component value change, added or deleted component, a component part number change, or a revised test and assembly procedure. The ERC label is the only one on the printed circuit board that has a four digit number. ERCs were implemented on this instrument with the introduction of the 03421-66511 motherboard. The first ERC was 2334. Refer to Chapter 1 (Mainframe Service Information), Section I for more information on ERC numbers.

## 4-7-5. CHAPTER CHANGES

4-7-6. Most changes in this section apply to the schematics and component locators in Section VIII, and to the parts list (Table 1-6-6) in Chapter 1, Section VI of the manual. If there is only a minor change, like a component value change or a minor circuit change, modify the schematic and Table 1-6-6 presently in the manual. If a major change to a schematic is made, refer to the schematic and component locator in this section of the chapter, instead of Section VIII.

4-7-7. If the ERC number of your option is different than listed on the title page, refer to Table 4-7-1 and locate the correct number for your option. Then make the changes to the chapter that are listed for your ERC number. When making the appropriate changes, make the highest number change first. For example, if changes 4 and 5 are listed, make change 5 first before making change 4.

4-7-8. If the ERC number is larger than listed on the title page or in Table 4-7-1, refer to the supplied *MANUAL CHANGES* supplement for updating information. Also, if a *MANUAL CHANGES* supplement is supplied, make all indicated ERRATA changes to correct any errors in this chapter.

4-7-9. If the component values or component part number differ from the ones shown on the schematic or parts list, and are NOT listed in this section or a *MANUAL CHANGES* supplement, replace with the component value and part number presently on the schematic and parts list.

**Table 4-7-1. Chapter 4 Changes**

| ERC | Make Changes |
|---|---|
| None | 7,6,5,4,3,2,1* |
| 2332 | 7,6,5,4,3,2 |
| 2343 | 7,6,5,4,3 |
| 2349 | 7,6,5,4 |
| 2351 | 7,6,5 |

* Change 1 may or may not be required on early assemblies.

## CHANGE 1

### Description

This changes the power supply circuitry on the HP-IB assembly. It involves deleting a resistor and capacitor, and changing the values of a zener diode and another resistor.

### Figure 4-8-25 (HP-IB Schematic) Changes

Do the following changes on the schematic.

Delete

1. C827 and R844
2. Place a jumper (JM1) in the R844 location

Change

1. CR804 to 5.6V
2. R803 to 4.71k

### Component Locator Changes

Use the component locator in Figure 4-7-1 instead of the locator in Figure 4-8-25.

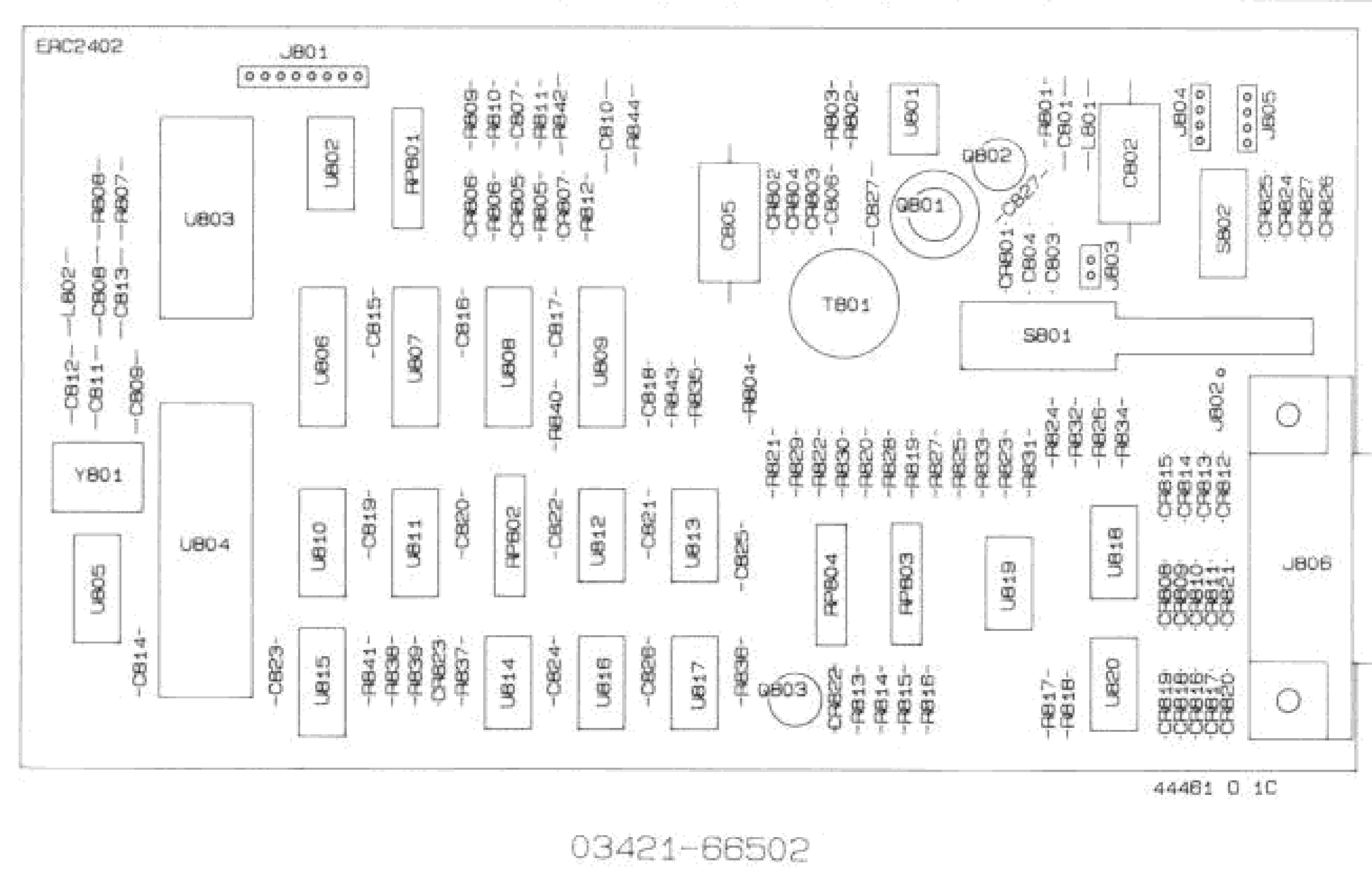



**Figure 4-7-1. Component Locator for Early HP-IB Assemblies**

**Table 1-6-6 (Replaceable Parts) Changes**

Do the following changes in the table.

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Delete: | | | | |
| C827 | 0160-3847 | 9 | | CAPACITOR-FXD .01UF +100-0% 50VDC CER |
| R844 | 0683-0275 | 9 | 1 | RESISTOR 2.7 5% .25W F C TC=-400/+500 |
| Change: | | | | |
| CR804 | 1902-0514 | 6 | 1 | DIODE-ZNR 5.62V 2% |
| R803 | 0683-4725 | 0 | 1 | RESISTOR 4700 5% .25W |

## CHANGE 2

**Description**

This changes the CR805 and CR806 diodes from germanium types to shotky types. If CR805 and/or CR806 are to be replaced, use part number presently in Table 1-6-6.

**Figure 4-8-25 (HP-IB Schematic) Changes**

Change the CR805 and CR806 symbols from regular diode to shotky.

**Table 1-6-6 (Replaceable Parts) Changes**

Do the following changes in the table.

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: | | | | |
| CR805 | 1901-0518 | 8 | 2 | DIODE-SM SIG SCHOTKY |
| CR806 | 1901-0518 | 8 | | DIODE-SM SIG SCHOTKY |

## CHANGE 3

**Description**

Commencing with ERC 2343, the internal code of U804 was changed resulting in an HP Part Number change to 1820-3428. Although initially U804 was an EPROM, the part number did not change with the hard ROM version. Also, U804 must have part number 1820-3428 (either EPROM or ROM) to be able to run signature analysis. If U804 is to be changed, use the part number presently in Table 1-6-6 of the manual.

**Table 1-6-6 (Replaceable Parts) Changes**

Do the following changes in the table.

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: U804 | 1820-2982 | 2 | 1 | (Under Miscellaneous) IC MASKED 8048 |

## CHANGE 4

### Description

This changes the protection circuitry of U803.

### Figure 4-8-25 (HP-IB Schematic) Changes

Delete CR824 thru CR827 from the schematic.

### Component Locator Changes

Delete CR824 thru CR827 from the component locator in Figure 4-8-25.

### Table 1-6-6 (Replaceable Parts) Changes

Do the following changes in the table.

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Delete: CR824-CR827 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 |
| Change: CR801 | 1901-0050 | 3 | 8 | DIODE-SWITCHING 80V 200MA 2NS DO-35 |

## CHANGE 5

### Description

This changes the value of the Q803 base resistor. If any wrong signature is obtained on the SRQ line (J806 pin 10), change to the resistor value presently in Table 1-6-6.

### Figure 4-8-25 (HP-IB Schematic) Changes

Change the value of R836 from 1.8k to 6.8k.

### Table 1-6-6 (Replaceable Parts) Changes

Do the following changes in the table.

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: R836 | 0683-6825 | 7 | 1 | RESISTOR 6.8K 5% .25W FC TC=-400/+700 |

## CHANGE 6

### Description

This changes the U802 comparator input circuitry.

### Figure 4-8-25 (HP-IB Schematic) Changes

Delete R845 and R846 from the schematic.

### Component Locator Changes

Delete R845 and R846 from the component locator in Figure 4-8-25.

### Table 1-6-6 (Replaceable Parts) Changes

Do the following changes in the table.

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Delete: | | | | |
| R845 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 |
| R846 | 0683-2225 | 3 | | RESISTOR 2.2K 5% .25W FC TC=-400/+700 |
| Change: R814 | 0683-2225 | 3 | 3 | RESISTOR 2.2K 5% .25W FC TC=-400/+700 |

## CHANGE 7

### Description

This changes the value of the Q803 base resistor. If any wrong signature is obtained on the SRQ line (J806 pin 10), change to the resistor value presently in Table 1-6-6.

### Figure 4-8-25 (HP-IB Schematic) Changes

Change the value of R836 from 1.8k to 3.3k.

### Table 1-6-6 (Replaceable Parts) Changes

Do the following changes in the table.

| Reference Designation | HP Part Number | C D | Qty | Description |
|---|---|---|---|---|
| Change: | | | | |
| R812 | 0683-1825 | 7 | 1 | RESISTOR 1.8K 5% .25W FC TC=-400/+700 |
| R813 | 0683-3325 | 6 | 4 | RESISTOR 3.3K 5% .25W FC TC=-400/+700 |
| R836 | 0683-3325 | 6 | | RESISTOR 3.3K 5% .25W FC TC=-400/+700 |

# SECTION VIII
# SERVICE

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 4-8-1. INTRODUCTION

4-8-2. This section contains the theory of operation, digital signature analysis troubleshooting, component locator, and schematics for the HP-IB option assembly.

## 4-8-3. BLOCK DIAGRAM THEORY OF OPERATION

4-8-4. Refer to the block diagram in Figure 4-8-24 for the following discussion. It is located on a foldout at the end of this section, just before the schematic.

4-8-5. The HP-IB assembly circuitry consists of five functional areas as follows:

HP-IL Interface Circuitry
HP-IB Interface Circuitry
CPU ($\mu$C)
Address Switches
Power Supply

### 4-8-6. HP-IL Interface Circuitry

4-8-7. The HP-IL chip is a receiver/transmitter IC that performs serial to parallel and parallel to serial conversions. Serial to parallel conversions occur when the instrument is talking over HP-IB. Parallel to serial conversions occur when the instrument is listening to HP-IB.

4-8-8. Resistors on the input of the comparators set the HP-IL signal detection threshold to 50 mV. The two resistors on the input lines to the mainframe provide the proper HP-IL drive.

4-8-9. The HP-IB/HP-IL pushbutton switch permits selection between HP-IB and HP-IL. When the switch is out, power to the HP-IB circuitry is removed and the mainframe is connected directly to the rear panel HP-IL connector. When the switch is in, power is supplied to the HP-IB circuitry and the rear panel HP-IL connector is disconnected from the mainframe.

### 4-8-10. HP-IB Interface Circuitry

4-8-11. Data to be output to the HP-IB is latched and then routed through transistor drivers. Information from the HP-IB is buffered and then routed to the $\mu$C.

### 4-8-12. CPU

4-8-13. The CPU handles input and output data and provides control line information for the input buffers and output latches. The CPU clock frequency is 6 MHz. At power on, the Reset line is held low until the power supply has reached a voltage that is sufficient for the clock to start (about 4.5V).

### 4-8-14. Address and Buffer Mode Enable Switches

4-8-15. At power on, these switches are read by enabling a buffer. These switches are factory preset for address "09" and buffered transfers disabled.

### 4-8-16. Power Supply

4-8-17. The power supply generates +5V from the internal battery of the instrument using a switching regulator technique.

## 4-8-18. SCHEMATIC DIAGRAM DESCRIPTION

4-8-19. The schematic diagram (Figure 4-8-25) is located at the end of this section on a foldout. Refer to the foldout for the following discussion.

### 4-8-20. HP-IL Interface Circuitry

4-8-21. U803 is a general purpose receiver/transmitter IC. It performs all serial to parallel and parallel to serial conversions, with automatic echo of commands and automatic ready for command (RFC) generation. The clock for this IC is 2 MHz, which is controlled by L802 and C808. Pullup resistors are required on the Read and Write lines for TTL compatibility.

4-8-22. U803 has three registers that are used for implementing the HP-IB circuitry. These include Status, Control/Interrupt, and Data Registers. The registers are selected by Register Select lines RS0 - RS2. This IC is described in detail in the HP-IL Integrated Circuits User Manual.

4-8-23. R807 and R808 provide the proper HP-IL drive without the use of a transformer. R805/CR805 and R806/CR806 load the HP-IL lines which result in signal levels between −.5V to +1.0V. The two resistors connected to the negative input of the two U802 comparators form a voltage divider which sets the HP-IL threshold point to 50 mV. R809 and R810 are pullup resistors which ensure that transitions seen by U803 are fast enough for detection.

#### 4-8-24. HP-IL/HP-IB Switching

4-8-25. Switch S801 provides a means to select between HP-IL and HP-IB. With S801 in the out position, the HP 3421A is connected to the rear panel HP-IL connector, and the path for the power supply input voltage (VB) is opened. By removing VB, +5V is not generated, which in turn removes power from the ICs on the HP-IB assembly. This conserves the charge on the internal battery. When S801 is in, the rear panel HP-IL connector is removed from the circuit and VB is restored. When VB is restored, +5V is generated which restores power to the ICs on the HP-IB assembly.

#### 4-8-26. HP-IB Interface Circuitry

4-8-27. Data to the HP-IB is output from U804 and latched into U809. The outputs then pass through the U818 and U819 transistor drivers to the HP-IB. The control, handshake, and SRQ lines are latched by U810 and U811 and then pass through the U820 and Q803 transistor drivers. The handshake process is discussed in more detail later.

4-8-28. Resistor R815 through R826 and R836 limit the base current of the HP-IB driver transistors to about 600 $\mu$A. Resistors R827 through R834 ensure that U818 and U819 are turned off when U809 is in tri-state.

4-8-29. RP803, RP804, R813, and R814 provide the standard bus load for HP-IB and an effective impedance of 1300 Ω. CR808 through CR823 provide protection from static discharge and clamping for negative going voltage excursions.

4-8-30. U812, U813, and U814 are low power Schottky Schmitt Trigger inverting input devices that handle data and control line input information. U807 and U808 handle the input data and control lines, respectively.

4-8-31. Part of U815 through U817 gate the signals necessary for the HP-IB handshake. The direction of the data lines and the NDAV, NRFD, and NDAC handshake lines is determined by the ATN and the Talker Active state. Also, if ATN goes true, the instrument must listen and handshake the data that follows even if it was not addressed to listen. U816A resets the control and handshake lines when a reset or IFC occurs.

#### 4-8-32. CPU (U804)

4-8-33. The CPU handles input and output data and provides control line information for the input buffers and output latches. The CPU clock frequency is 6 MHz which is controlled by the Y801 external crystal. At power on, the Reset line is held low until the power supply has reached a voltage that is sufficient for the clock to start (about 4.5V).

4-8-34. Switch segments 7 and 8 of S802 are connected to T0 and T1 of the CPU. These switch segments, along with P23 and ALE, are used to run digital signature analysis. For normal operation switch segments 7 and 8 must be in the "0" (up) position.

**NOTE**

*To run a signature analysis test on an HP-IB option assembly, U804 must have a part number of 1820-3428. Signature analysis was not implemented on early assemblies where U804 had a part of 1820-2982. To run a signature analysis test on an early assembly, U804 must be replaced with part number 1820-3428. U804 was changed to part number 1820-3428 starting with engineering revision code (ERC) 2343.*

4-8-35. U802 is a comparator that holds the CPU in a Reset state until the power supply voltage is high enough to allow the clock to start (approximately 4.5V). The same reset line also goes to the HP-IL chip (U803).

### 4-8-36. HP-IB Address, Buffered Transfer, and Signature Analysis Switches

4-8-37. Switch S802 is an eight segment switch that sets the HP-IB address, enables and disables buffered transfers, or selects an SA test. The "0" position of a switch segment corresponds to it being closed (up); a "1" position corresponds to it being open (down). These switch settings were illustrated in Section II. Switch positions of up, down, 0, and 1 assume that the switches are being viewed from the rear panel with the assembly installed in the instrument.

4-8-38. Switch segments 1 through 5 set the HP-IB address. The factory preset address is "09". Switch segment 6 is used to enable and disable buffered transfers. When switch segment 6 is closed, buffered transfers are disabled. This is the normal mode of operation and is factory preset. For switch segments 1 through 6 to be read by the CPU, U806 must be enabled. This occurs only at power on or reset.

4-8-39. As previously explained, switch segments 7 and 8 are used to select a signature analysis test and must be closed for normal operation.

### 4-8-40. Power Supply

4-8-41. The power supply is a switching regulator type. It operates from the instruments internal battery voltage (VB) to generate +5V (+5%, −10%).

4-8-42. Q801, Q802, and T801 form a free running oscillator. Pulses on the primary side of T801 are coupled to the secondary and rectified by CR802. The rectified voltage is filtered by C805 and C806. CR804 and R844 regulate the output voltage.

4-8-43. U801 is an optoisolator used for negative feedback to control how hard Q801 and Q802 turn on. This technique provides both isolation and regulation.

## 4-8-44. TROUBLESHOOTING WITH SIGNATURE ANALYSIS

4-8-45. Signature analysis (SA), is a component level troubleshooting technique which enhances the serviceability of microprocessor based products. It is based on the premise that digital data is predictable at a given point in a circuit if specific programming conditions are met. While running a built-in SA routine, the data appearing at a circuit node is analyzed over a controlled period (window). This results in a unique four character signature which is displayed on the signature analyzer. If the signature matches the one listed for that test, then that part of the circuit is operating properly. If the signatures do not match, some circuit component is probably defective.

### 4-8-46. Incorrect Signatures

4-8-47. If a circuit node has an incorrect signature, it does not necessarily mean that the devices connected to that node are defective. An incorrect signature could mean that some other device is providing incorrect signals, or your setup may be wrong. In some instances, the signatures may not match because of a change in the internal ROM code, or perhaps there has been a hardware modification. Always make sure you have the manual that is applicable to the assembly you are troubleshooting.

4-8-48. Common digital circuit failures include stuck lines. A line can be stuck at 0V (low or GND), +5V (high), or anywhere between 0V and +5V. In any event, a stuck line does not make transitions. Depending upon the level of the stuck line, and because of the threshold requirements of the signature analyzer, it will cause a GND or +5V signature to be indicated. Also, the probe tip may be "ON", "OFF", or even "Flickering" when a stuck line is encountered. In the tables that follow, some signatures will be noted as GND or +5V signatures. When they are noted as such in the signature tables, they are valid signatures.

4-8-49. If a circuit node is stuck low, use a high resolution voltmeter and check all devices connected to that node. The defective device will be sinking the most current, and therefore usually have the largest voltage at its pin connected to the circuit node. This voltage is usually very small, and is developed by the current trace going to the pin of the defective device.

4-8-50. If a circuit node is stuck high, make sure the inputs to the device are good. If an input is bad, trace the bad signal back to its source. If the inputs to the device are good, it could be any device connected to the node with the incorrect signature that is defective. A general rule is to suspect the device sourcing the signature, although this may not always be the problem.

4-8-51. Another type of incorrect signature is one that is different than the one listed for the circuit node under test, but it is not a GND or +5V signature. This can be caused by incorrect timing, data, etc.. Generally, if this type of signature is encountered, it should be traced to its source. That is, use the schematics and trace back through the circuitry until you find the location where the incorrect signal starts. When you find the component where its output signature is wrong but its input signature(s) is correct, replace that device.

### 4-8-52. Signature Analysis Tests

4-8-53. To run any of the SA tests, U804 must have a part number of 1820-3428. In early HP-IB assemblies, U804 had a part number of 1820-2982, which did not support SA. If you have an early assembly and want to troubleshoot using SA, replace part number 1820-2982 with part number 1820-3428. U804 was changed to part number 1820-3428 starting with engineering revision code (ERC) 2343.

4-8-54. There are three SA tests that can be run. The position of switch segments 7 and 8 of S802 determines which test, if any, is being run. These switches are only read at reset or power on. Thus, once an SA test is being executed, it is possible to go to another SA test without cycling power. However, all SA routines are aborted when switch segments 7 and 8 are simultaneously set toward the pc board. To resume running an SA routine, switch segments 7 and 8 must be set back to the appropriate positions for the SA test to be run, and the power must be cycled or the HP 3421A must be reset.

4-8-55. SA Test #1 is useful to verify that the HP-IB board is functional. It allows you to verify the operation of the CPU (U804); CPU ROM and RAM; HP-IB address, data, and control lines; HP-IL circuitry and switch S802. SA Test #2 is used to troubleshoot HP-IL circuitry. SA Test #3 is used to troubleshoot the HP-IB circuitry. You should start with SA Test #1 as it will guide you in selecting one of the other tests should the failure be in the HP-IL or HP-IB circuitry.

### 4-8-56. Limitations of the SA Tests

4-8-57. The SA tests will isolate the vast majority of problems with the HP-IB option assembly. However, the tests do have limitations. For example, SA Test #1 will perform a 95% functional check of the internal CPU RAM. Likewise, SA Test #2 will perform a 95% functional check of the HP-IL chip (U803). Also, the procedure for SA Test #2 opens the HP-IL loop to the mainframe, and therefore will not guarantee that a mainframe HP-IL problem does not exist. Another limitation of the tests is that they do not check the rear panel HP-IB connector (J806).

### 4-8-58. Troubleshooting Setup

4-87-59. To troubleshoot the HP-IB option using SA, it is necessary to remove the option from the instrument, but leave the power supply connected to the mainframe. Use the following procedure to setup the option for troubleshooting.

a. Make sure the HP 3421A is turned off and ac power cord is disconnected from the instrument. Also make sure all external sources of power have been removed from the option terminal blocks.

b. Turn the instrument upside down. This is preferably done on top of a protective mat to reduce the possibility of scratching or marring the instrument case. Refer to Figure 4-8-1 and loosen the six screws on the instrument bottom.

c. Hold the top cover in place and turn the instrument upright. Then remove the top cover.

d. If there is no option in slot 2, continue with step g. If there is an option in slot 2, remove the black strain relief and grey "WARNING" safety cover form slot 2 as follows:

1. Remove the two screws holding the black strain relief bar.

2. Loosen the two captive screw that hold the grey "WARNING" safety cover.

3. Loosen the two screws holding the terminal block to the option circuit board and then remove the terminal block.

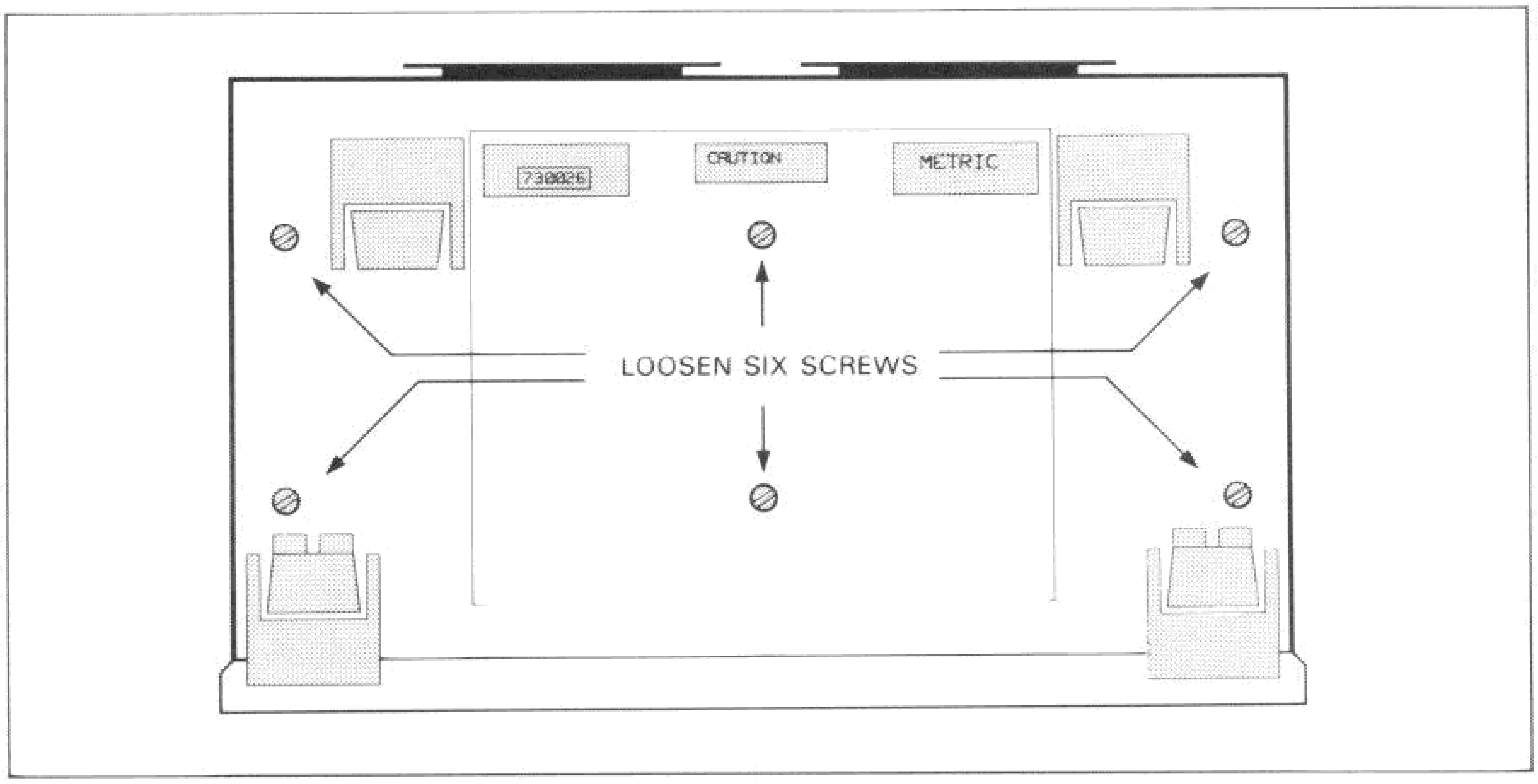



Figure 4-8-1. HP 3421A Case Disassembly

e. Refer to Figure 4-8-2. Unplug the ribbon cable connector from the option in slot 2. Lift the connection straight up to avoid bending any pins. If the option is a Multiplexer Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

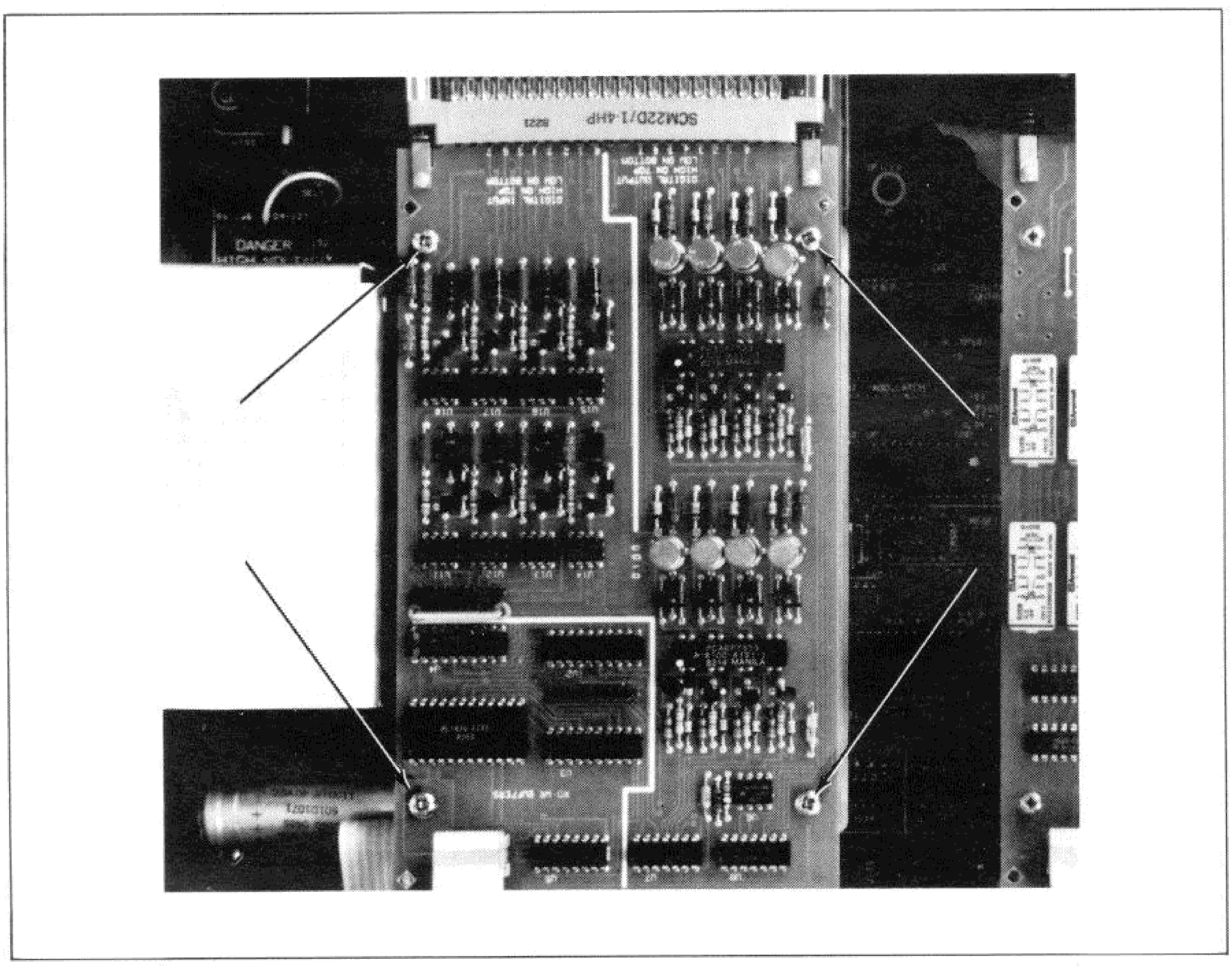


Figure 4-8-2. Removing the Slot 2 Option

f. Locate and remove the four screws holding the option in place. Remove the slot 2 option.

g. Loosen the two screws that secure the HP-IB option to the rear panel.

h. Unplug the 4-wire cable from J804 on the HP-IB board. This is the cable with the blue and yellow wires. The other end of the cable may be left connected to the motherboard. Also leave the green-white wire connected to J802 and the red-black wire connected to J803.

i. Set the HP-IB option on a flat surface as shown in Figure 4-8-3. To prevent any shorting on the board, set it on a non-conductive surface.

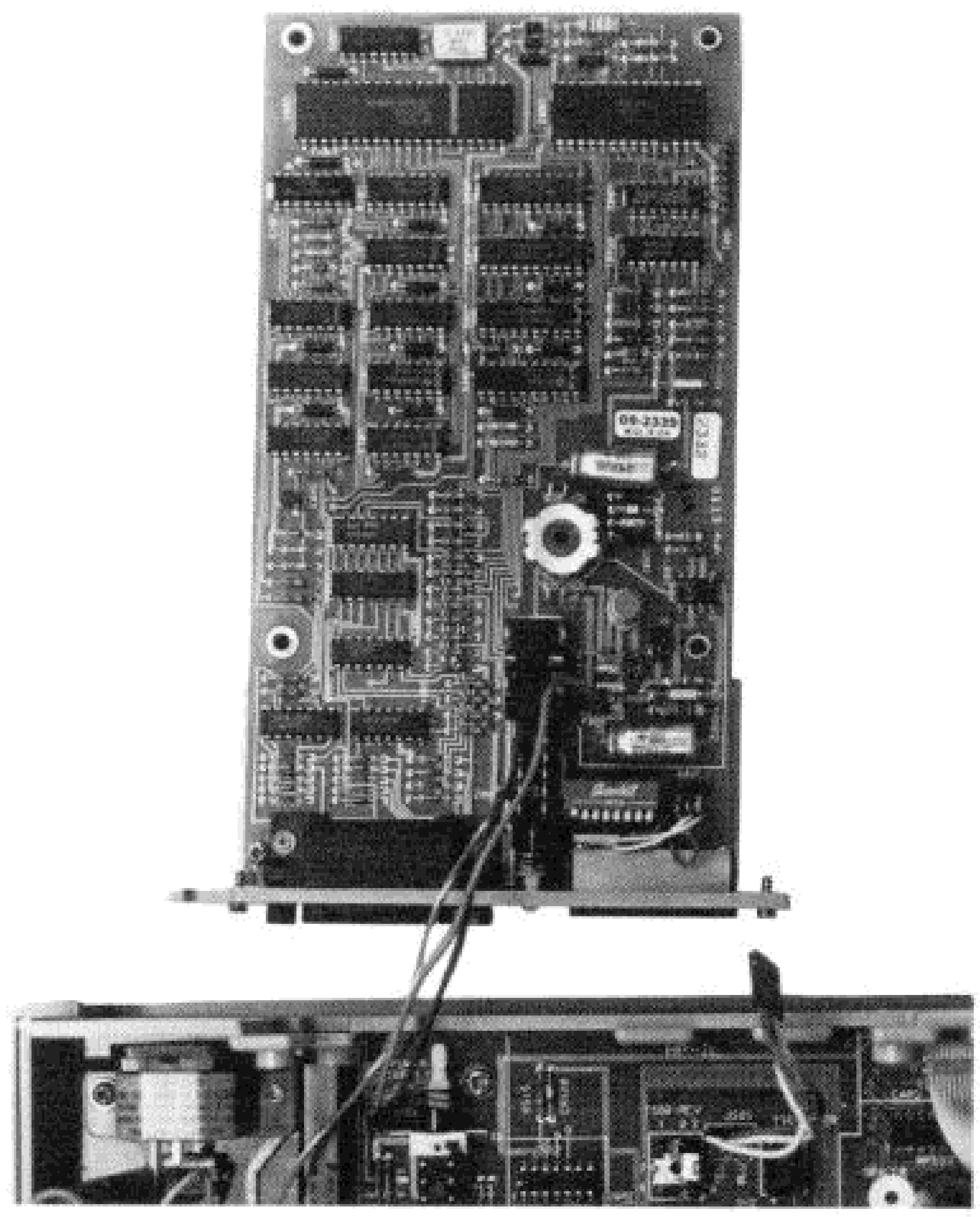


**Figure 4-8-3. Set HP-IB Option on Work Surface**

j. This completes the troubleshooting setup. Refer to Section II in this chapter to reassemble the instrument.

### 4-8-60. Pre-Troubleshooting Checks

4-8-61. Perform the following procedure before checking any signatures.

a. With ac power connected to the HP 3421A, turn the instrument's front panel switch on.

b. Press the HP-IB/HP-IL switch to the HP-IB position (in). This powers up the HP-IB assembly.

c. Make the following checks.

1. Check the HP-IB on-board power supply at J801 pin 1 or 2 for +5V (±.25V). J801 pin 1 is labeled with a "1"; J802 pin 2 is labeled with a "V". A convenient ground reference for the test instrument is J801 pin 6 or 7 (labeled G). If +5V is incorrect, refer to paragraph 4-8-80 for troubleshooting.

2. Set an oscilloscope to 1μS/div sweep time and 2V/div vertical gain. Check ALE at U804 pin 11 for the waveform shown in Figure 4-8-4. MANUAL.

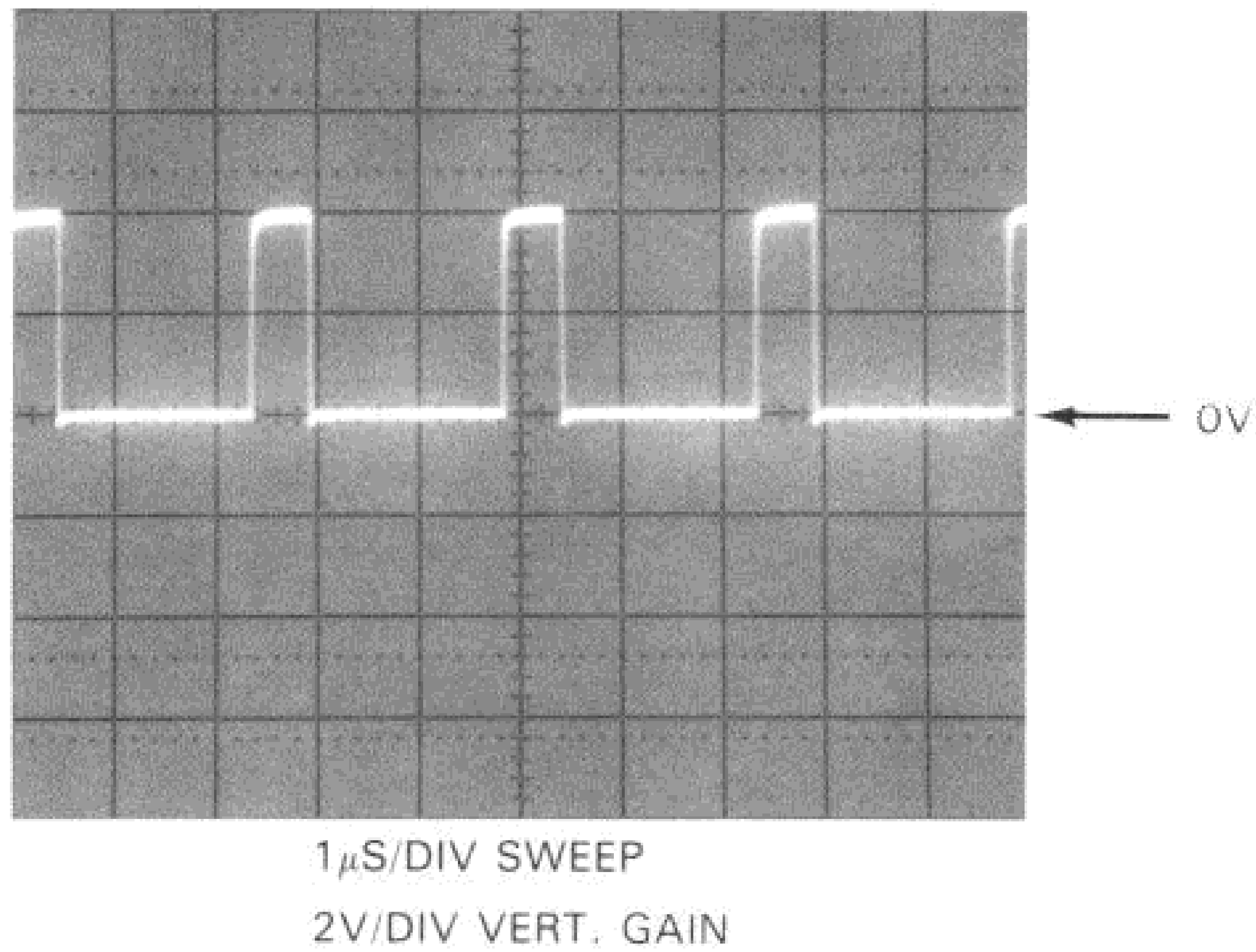



**Figure 4-8-4. ALE at U804 pin 11**

3. Check the RESET line at U804 pin 4 for a TTL high. The CPU (U804) and HP-IL chip (U803) will not run if the RESET line is low. If RESET is low, U802 and associated components are suspect.

4. Check the CPU interrupt line at U804 pin 6 for a TTL high. If this line is low, U814 or U815 is suspect.

5. Set the oscilloscope to .2μS/div sweep time and 2V/div vertical gain. Check the HP-IL clock at U803 pins 23 and 24 as shown in Figure 4-8-5.

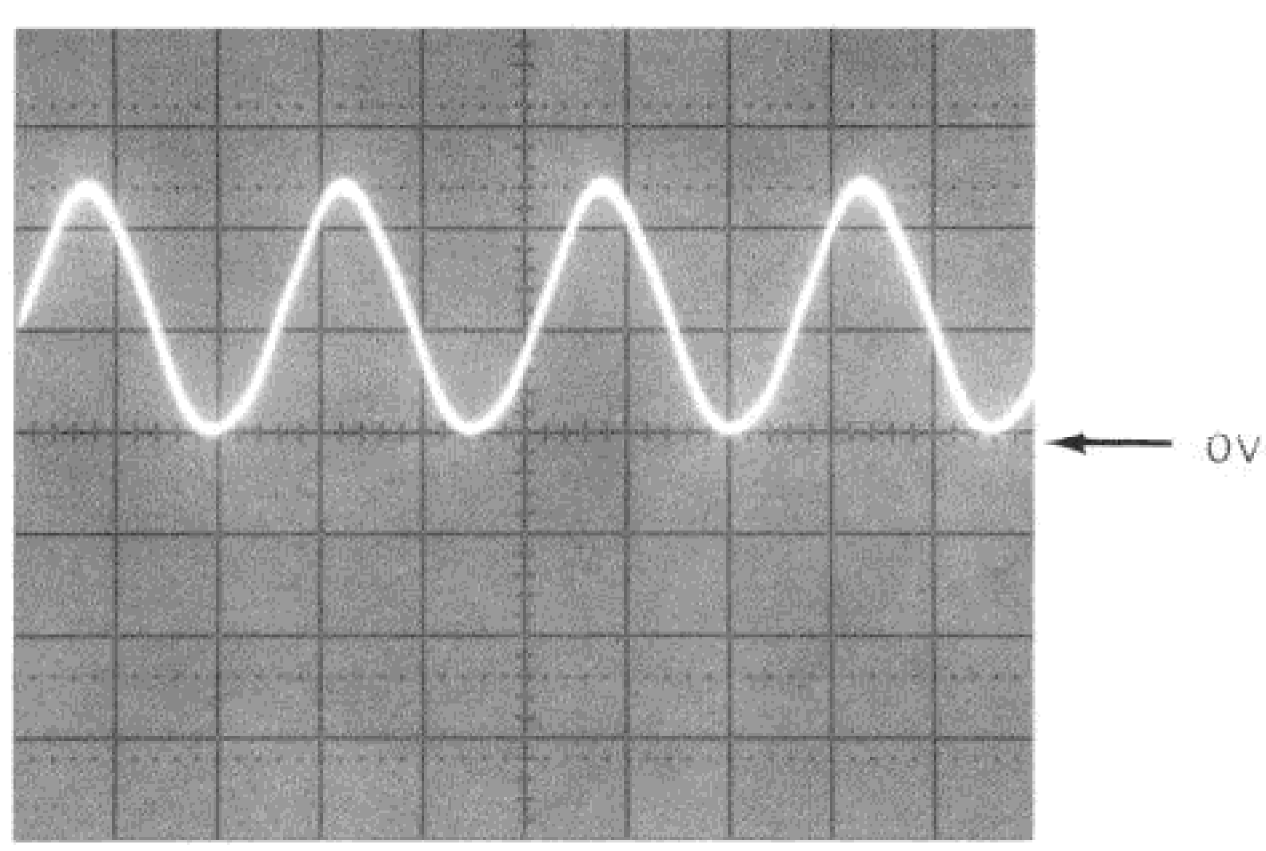



**Figure 4-8-5. HP-IL Clock at U803. pins 23 and 24**

6. Check for a TTL low at U816 pin 3. If this line is high, either U816 or the components driving the inputs to U816A are suspect.

#### 4-8-62. SA Test #1 (Operational Test)

4-8-63. Run this test first. It verifies the operation of the CPU ROM, CPU RAM (see limitations in paragraph 4-8-56), or directs you when it is appropriate to troubleshoot the HP-IL circuitry (SA Test #2) or the HP-IB circuitry (SA Test #3).

4-8-64. Perform the following procedure to run SA Test #1.

a. Press the rear panel HP-IB/HP-IL switch (S801) to the HP-IL position (out).

b. Refer to Figure 4-8-6 and set the switch segment of S802 as follows:

segments 1-6 toward the pc board (closed)
segments 7 and 8 away from the pc board (open)

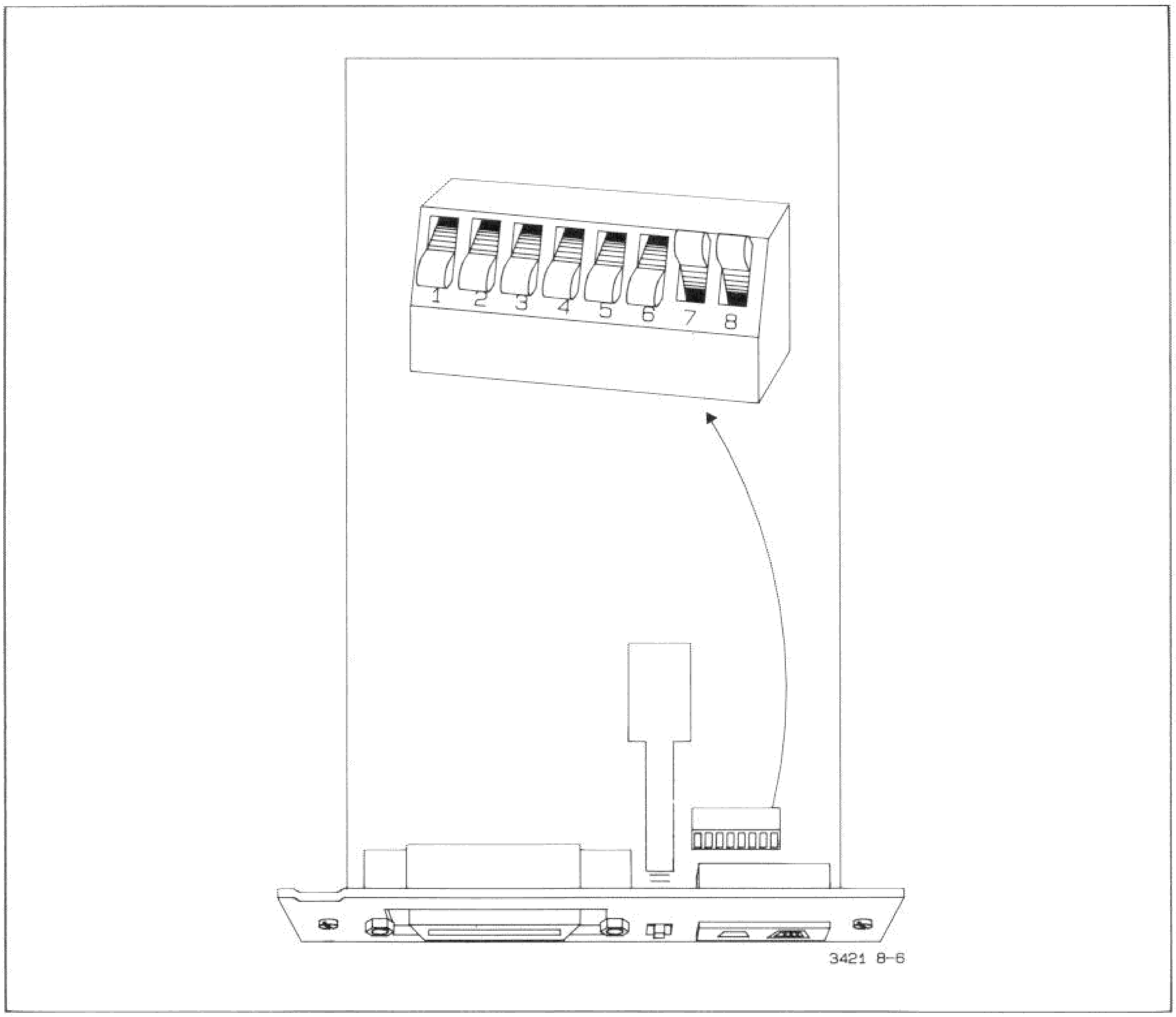



**Figure 4-8-6. S802 Switch Settings for SA Test #1**

c. Refer to Figure 4-8-7 and perform the following jumper configuration.

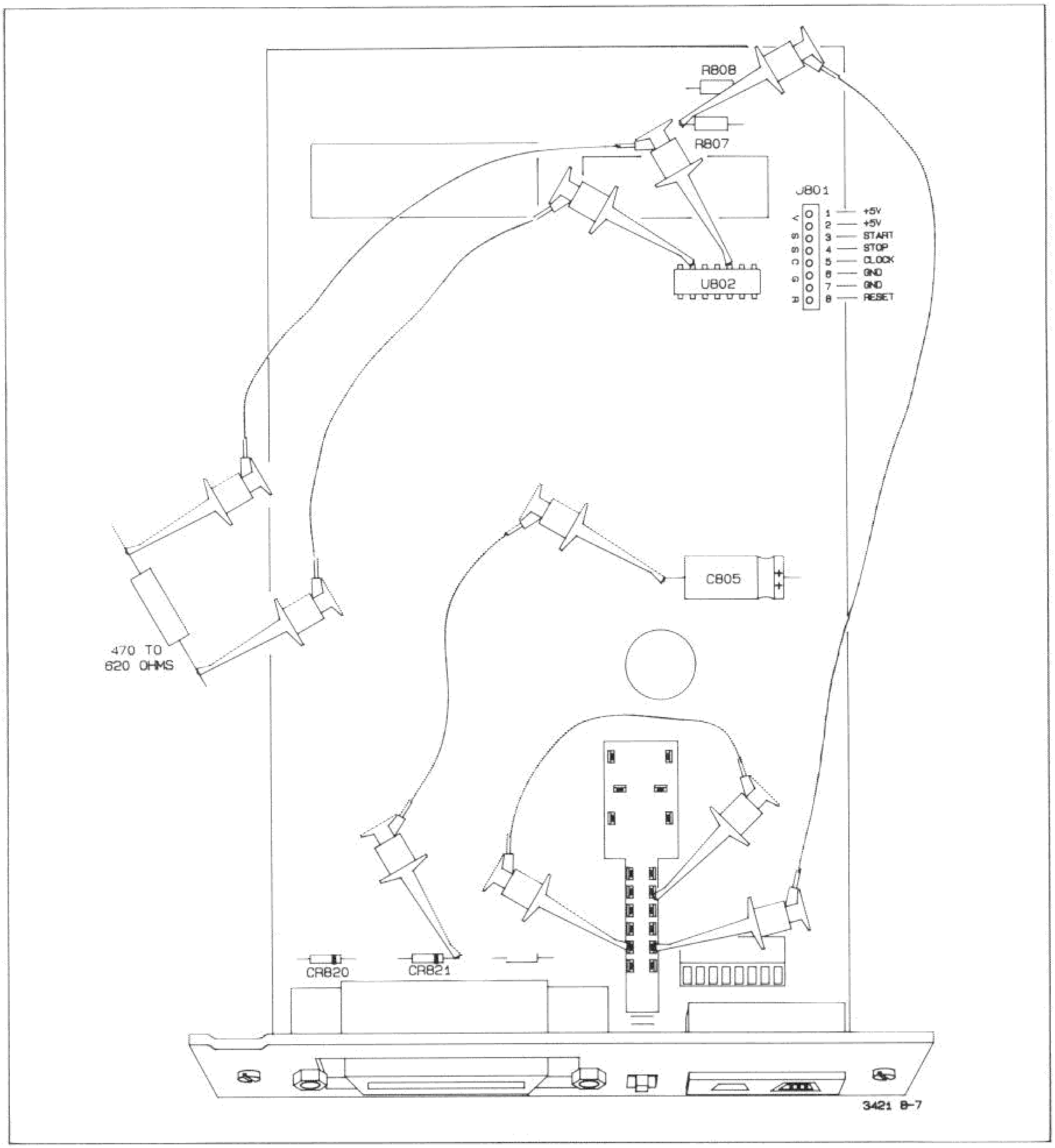



**Figure 4-8-7. Jumper Configuration for SA Test #1 (HP-IL Signatures)**

1. Use a cliplead jumper and connect S801 lug 5 to S801 lug 17.

2. Connect a cliplead jumper between S801 lug 2 and the side of R807 shown.

3. Connect a cliplead jumper between the cathode of CR821 (banded end) and the negative (-) side of C805.

4. Locate a 4700Ω to 6200Ω resistor with a rating of 1/8W or greater and connect between pins 3 and 6 of U802 as shown. It may be easier to use an IC clip rather than make jumper connections directly to the IC pins.

d. Set the signature analyzer as follows:

| | | |
|---|---|---|
| START | = | (out) |
| STOP | = | (out) |
| CLOCK | = | (out) |

e. Connect the signature analyzer as follows:

START to J801 pin 3
STOP to J801 pin 4
CLOCK to J801 pin 5
GND to J801 pin 6 or 7

f. Make sure the HP 3421A front panel switch is on.

g. Press the rear panel HP-IB/HP-IL switch (S801) to the HP-IB position (in). This powers up the HP-IB assembly.

h. The +5V signature displayed on the signature analyzer indicates one of the following conditions.

| +5V Signature | Condition |
|---|---|
| F7H0 | CPU ROM and RAM good. Proceed to paragraph 4-8-65. |
| AC5H | CPU ROM defective. Replace U804 |
| neither of the above | CPU RAM defective or incorrect setup. Check setup. If setup is good, replace U804. |

**4-8-65. HP-IL Signatures (SA Test #1).** The HP-IL signatures are listed in Table 4-8-1. Check the signature at port 12 (U804 pin 29) first. This verifies if the setup is correct, specifically that the HP-IL transmit is connected via the jumpers to the HP-IL receive. If all of the HP-IL signatures are correct, proceed with the HP-IB signatures (paragraph 4-8-67). If an HP-IL signature is incorrect, proceed to SA Test #2 to isolate the defective component.

4-8-66. Refer to Figure 4-8-8 and check pin 10 of the rear panel HP-IB connector (J806) for a signature of 4C11. The rear panel HP-IB connector is illustrated upside down as this is the way it should be positioned on your work surface. If the signature is wrong, proceed to SA Test #3 to isolate the defective component. If the rear panel signature is correct, check the HP-IB signatures in this test (paragraph 4-8-67).

Table 4-8-1. HP-IL Signatures (SA Test #1)

+5V Signature: F7H0

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| Port 12 | Data Bit 3 | U804(29) | ACH5* | U806(14),U807(14), U808(14),U809(7), U810(12) |
| Port 10 | Data Bit 1 | U804(27) | 9PFP | U806(18),U807(18), U808(18),U809(3), U810(14) |
| Port 11 | Data Bit 2 | U804(28) | HPF0 | U806(16),U807(16), U808(16),U809(4), U810(13) |
| Port 13 | Data Bit 4 | U804(30) | 6FFF | U806(12),U807(12), U808(12),U809(8), U810(11) |
| Port 14 | Data Bit 5 | U804(31) | 5P6C | U806(9),U807(9), U808(9),U809(13), U811(14) |
| Port 15 | Data Bit 6 | U804(32) | 8P92 | U806(7),U807(7), U808(7),U809(14), U811(13) |
| Port 16 | Data Bit 7 | U804(33) | 21A8 | U806(5),U807(5), U808(5),U809(5), U811(12) |
| Port 17 | Data Bit 8 | U804(34) | 3U01 | U806(3),U807(3), U808(3),U809(3), U811(11) |

* If this signature is U1P3, there is an open in the HP-IL loop. This is most likely caused by an incorrect placement of one or more of the jumpers.

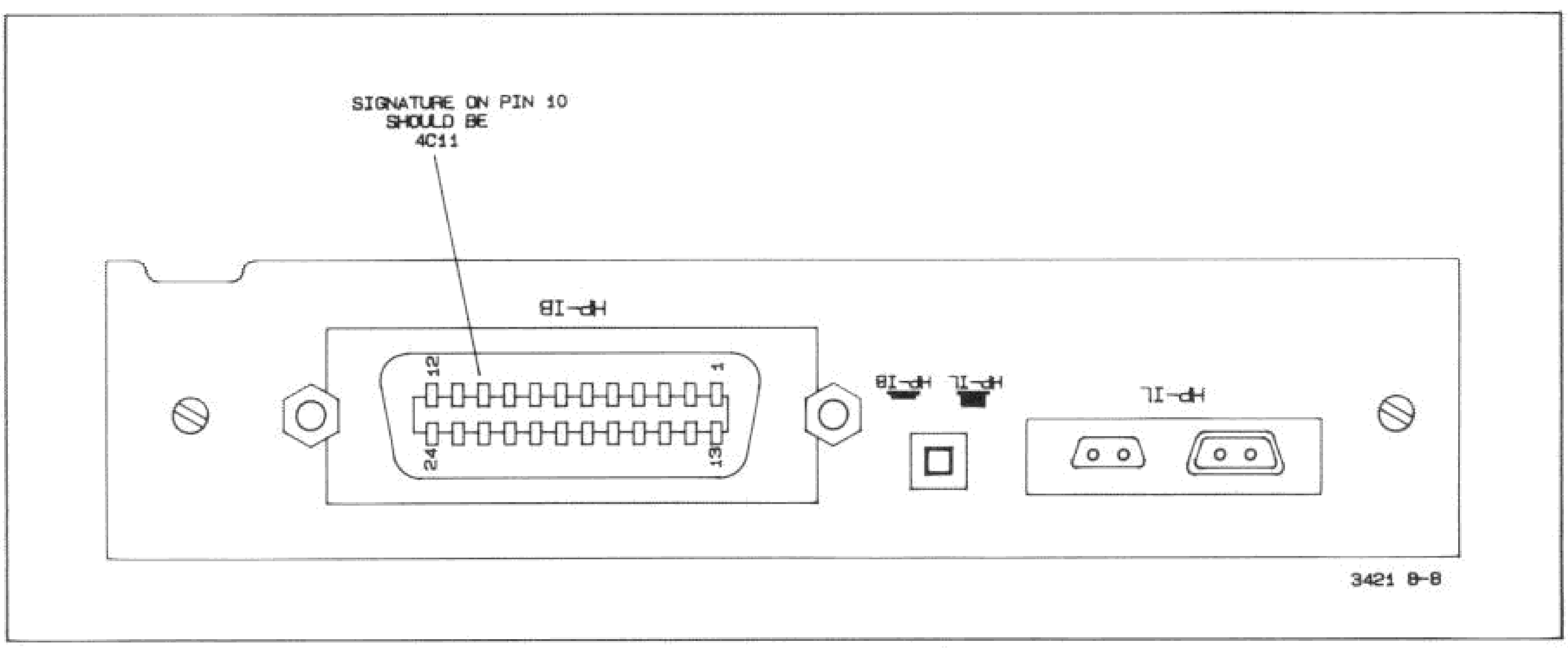



Figure 4-8-8. J806 pin 10 Signatures (SA Test #1)

**4-8-67. HP-IB Signatures (SA Test #1).** These signatures are listed in Table 4-8-2. The board configuration shown in Figure 4-8-9 is the same as the HP-IL signatures, except that the jumper that was configured on the cathode of CR821 has been moved to the cathode of CR820.

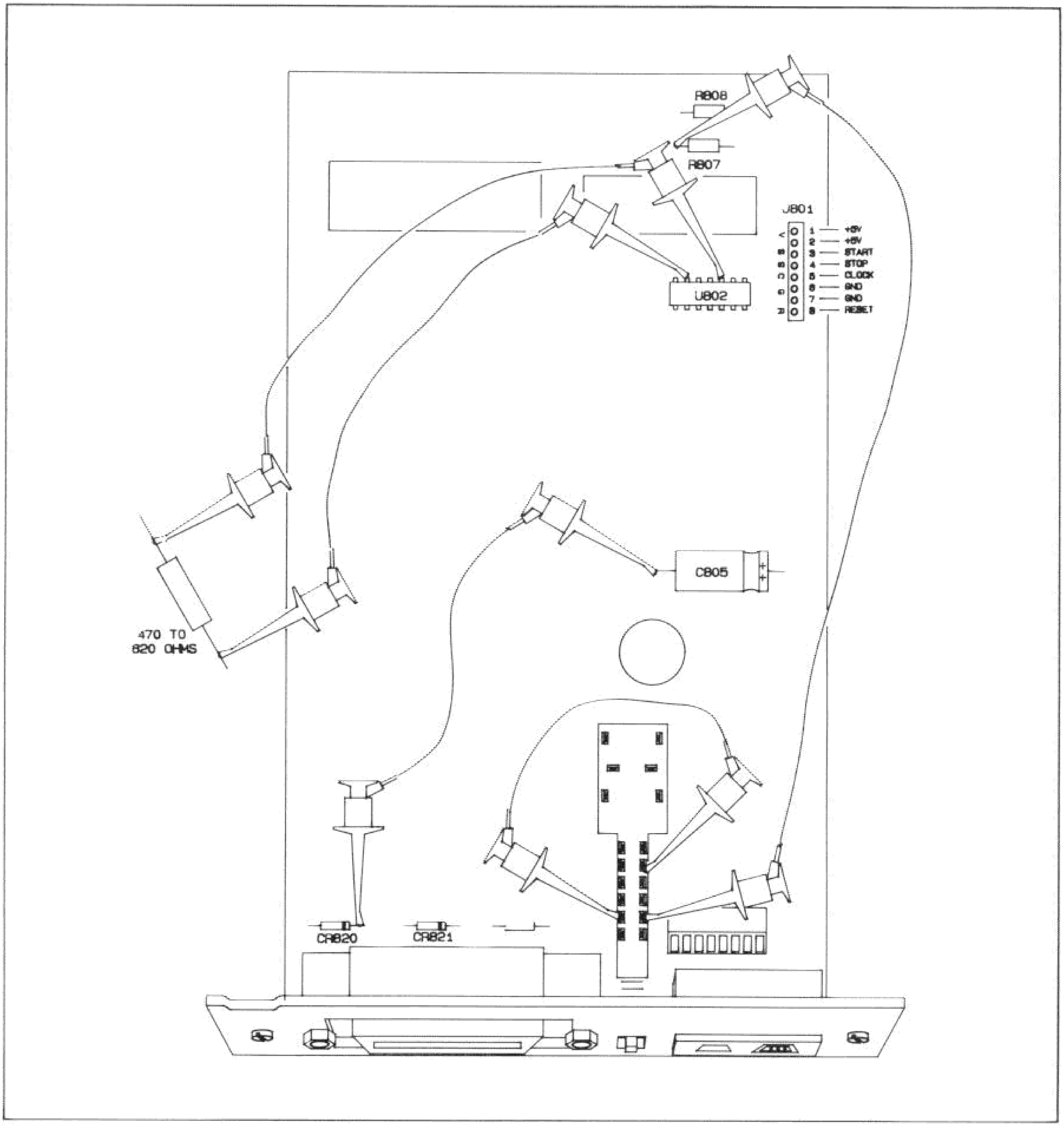



**Figure 4-8-9. Jumper Configuration for SA Test #1 (HP-IB Signatures)**

Table 4-8-2. HP-IB Signatures (SA Test #1)

+5V Signature: F7H0

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| Port 12 | Data Bit 3 | U804(29) | 14PU* | U806(14),U807(14), U808(14),U809(7), U810(12) |
| Port 10 | Data Bit 1 | U804(27) | FF0C | U806(18),U807(18), U808(18),U809(3), U810(14) |
| Port 11 | Data Bit 2 | U804(28) | 721C | U806(16),U807(16), U808(16),U809(4), U810(13) |
| Port 13 | Data Bit 4 | U804(30) | 854C | U806(12),U807(12), U808(12),U809(8), U810(11) |
| Port 14 | Data Bit 5 | U804(31) | 66A9 | U806(9),U807(9), U808(9),U809(13), U811(14) |
| Port 15 | Data Bit 6 | U804(32) | H1U2 | U806(7),U807(7), U808(7),U809(14), U811(13) |
| Port 16 | Data Bit 7 | U804(33) | 8A2H | U806(5),U807(5), U808(5),U809(5), U811(12) |
| Port 17 | Data Bit 8 | U804(34) | 8PF0 | U806(3),U807(3), U808(3),U809(3), U811(11) |

* If this signature is 4PH9, there is an open in the HP-IL loop. This is most likely caused by an incorrect placement of one or more of the jumpers.

4-8-68. Check the signature at port 12 (U804 pin 29) first. This verifies if the setup is correct. If all of the HP-IB signatures are correct, proceed to the S802 signatures (paragraph 4-8-69). If any HP-IB signature is incorrect, proceed with SA Test #3.

**4-8-69. S802 Signatures (SA Test #1).** The jumper configuration is the same as used for obtaining the HP-IB signatures (Figure 4-8-9). In these checks, switch segments 1 through 6 of S802 are opened one at a time while the remaining switch segments are closed. If all signatures are correct, the HP-IB board is operational (assuming the HP-IL and HP-IB signatures have been checked). If any signature is incorrect, check for a defective switch segment at S802, short or open traces, a defective pullup resistor (RP801), etc. If you find an incorrect signature, refer to paragraph 4-8-71 for problem isolation.

4-8-70. Perform the following procedure to verify S802 signatures.

a. Make sure the jumper configuration is the same as outlined in Figure 4-8-9.

b. Refer to Figure 4-8-10 and move switch segment 1 of S802 to the up position (away from the pc board). Leave switch segment 2 through 6 in the down position (toward the pc board). Switch segments 7 through 8 are left in the up position for this test. The signatures for this setup are listed in Table 4-8-3.

NOTE

*If switch segments 7 and 8 are placed in the down position simultaneously, the HP-IB option will exit the SA test that is running. To rerun the SA Test, move switch segments 7 and 8 back to their appropriate positions and cycle power by pressing the HP 3421A front panel switch off and then on.*

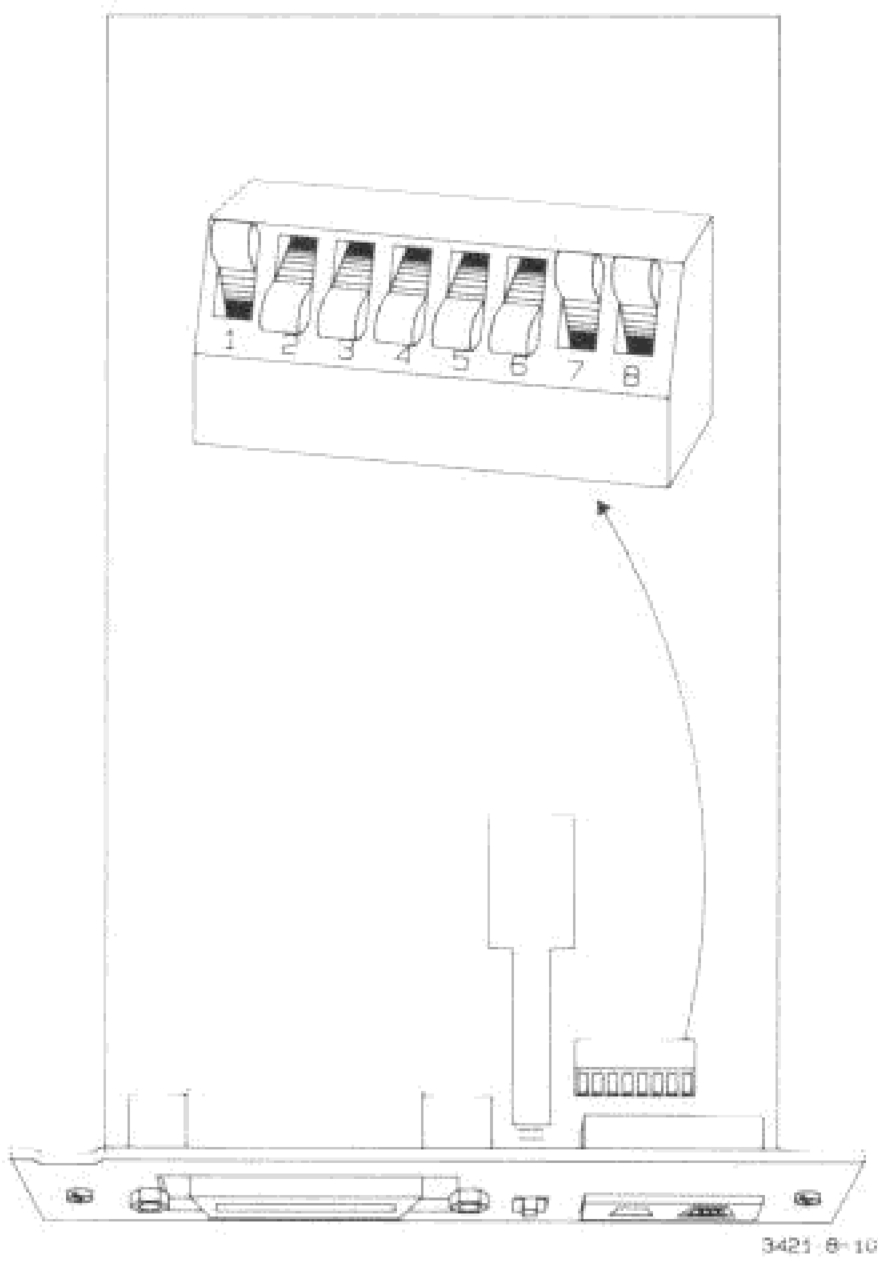



**Figure 4-8-10. S802 Switch Settings for Signature in Table 4-8-3**

**Table 4-8-3. Signatures for Figure 4-8-10 Switch Settings (SA Test #1)**

S802(1,7,8) away from the board
S802(2-6) toward the board

+5V Signature: F7H0

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| Port 10 | Data Bit 1 | U804(27) | 61FH | U806(18),U807(18), U808(18),U809(3), U810(14) |
| Port 11 | Data Bit 2 | U804(28) | 721C | U806(16),U807(16), U808(16),U809(4), U810(13) |
| Port 12 | Data Bit 3 | U804(29) | 14PU | U806(14),U807(14), U808(14),U809(7), U810(12) |
| Port 13 | Data Bit 4 | U804(30) | 854C | U806(12),U807(12), U808(12),U809(8), U810(11) |
| Port 14 | Data Bit 5 | U804(31) | 66A9 | U806(9),U807(9), U808(9),U809(13), U811(14) |
| Port 15 | Data Bit 6 | U804(32) | H1U2 | U806(7),U807(7), U808(7),U809(14), U811(13) |

c. Set the S802 switch segments as shown in Figure 4-8-11 and check for the signatures listed in Table 4-8-4. If any signature is incorrect, refer to paragraph 4-8-71 to isolate the defective area. If all signatures are correct, proceed with step d.

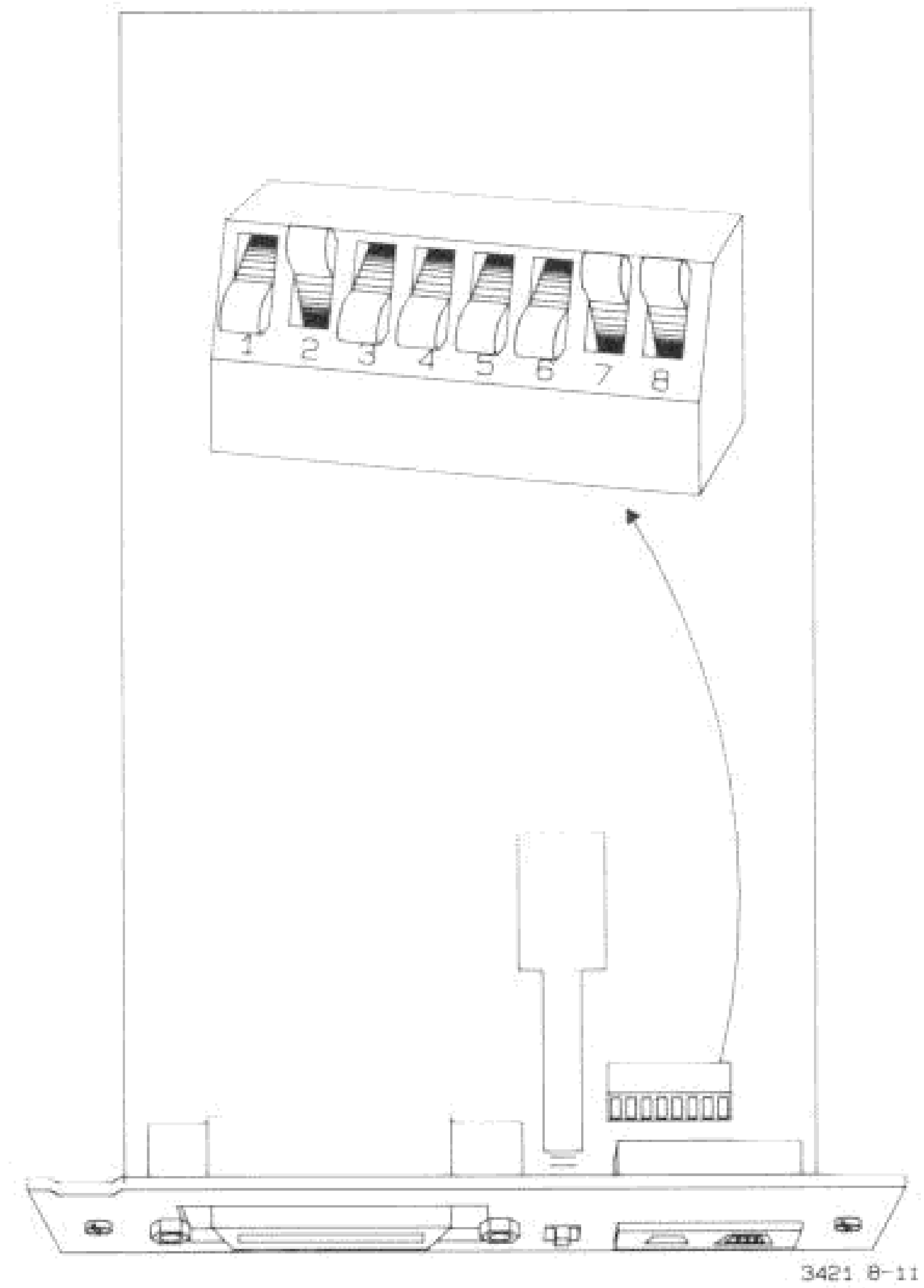



**Figure 4-8-11. S802 Switch Settings for Signatures in Table 4-8-4**

**Table 4-8-4. Signatures for Figure 4-8-11 Switch Settings (SA test #1)**

S802(2,7,8) away from the board
S802(1,3-6) toward the board

+5V Signature: F7H0

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| Port 10 | Data Bit 1 | U804(27) | FF0C | U806(18),U807(18), U808(18),U809(3), U810(14) |
| Port 11 | Data Bit 2 | U804(28) | HUHH | U806(16),U807(16), U808(16),U809(4), U810(13) |
| Port 12 | Data Bit 3 | U804(29) | 14PU | U806(14),U807(14), U808(14),U809(7), U810(12) |
| Port 13 | Data Bit 4 | U804(30) | 854C | U806(12),U807(12), U808(12),U809(8), U810(11) |
| Port 14 | Data Bit 5 | U804(31) | 66A9 | U806(9),U807(9), U808(9),U809(13), U811(14) |
| Port 15 | Data Bit 6 | U804(32) | H1U2 | U806(7),U807(7), U808(7),U809(14), U811(13) |

d. Set the S802 switch segments as shown in Figure 4-8-12 and check for the signatures listed in Table 4-8-5. If any signature is incorrect, refer to paragraph 4-8-71 to isolate the defective area. If all signatures are correct, proceed with step e.

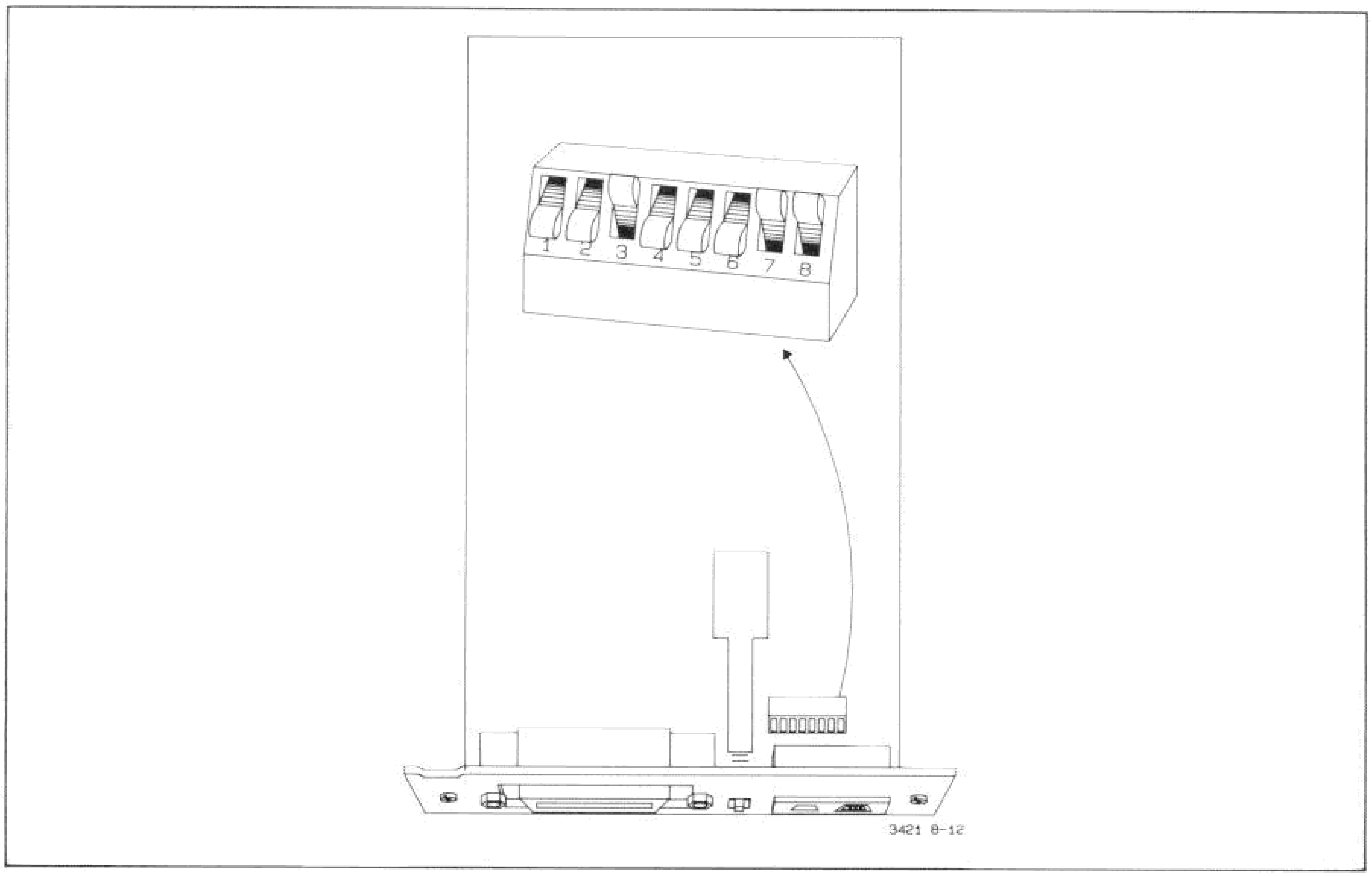



**Figure 4-8-12. S802 Switch Settings for Signatures in Table 4-8-5**

**Table 4-8-5. Signatures for Figure 4-8-12 Switch Settings (SA test #1)**

S802(3,7,8) away from the board
S802(1,2,4-6) toward the board

+5V Signature: F7H0

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| Port 10 | Data Bit 1 | U804(27) | FF0C | U806(18),U807(18), U808(18),U809(3), U810(14) |
| Port 11 | Data Bit 2 | U804(28) | 721C | U806(16),U807(16), U808(16),U809(4), U810(13) |
| Port 12 | Data Bit 3 | U804(29) | C929 | U806(14),U807(14), U808(14),U809(7), U810(12) |
| Port 13 | Data Bit 4 | U804(30) | 854C | U806(12),U807(12), U808(12),U809(8), U810(11) |
| Port 14 | Data Bit 5 | U804(31) | 66A9 | U806(9),U807(9), U808(9),U809(13), U811(14) |
| Port 15 | Data Bit 6 | U804(32) | H1U2 | U806(7),U807(7), U808(7),U809(14), U811(13) |

e. Set the S802 switch segments as shown in Figure 4-8-13 and check for the signatures listed in Table 4-8-6. If any signature is incorrect, refer to paragraph 4-8-71 to isolate the defective area. If all signatures are correct, proceed with step f.

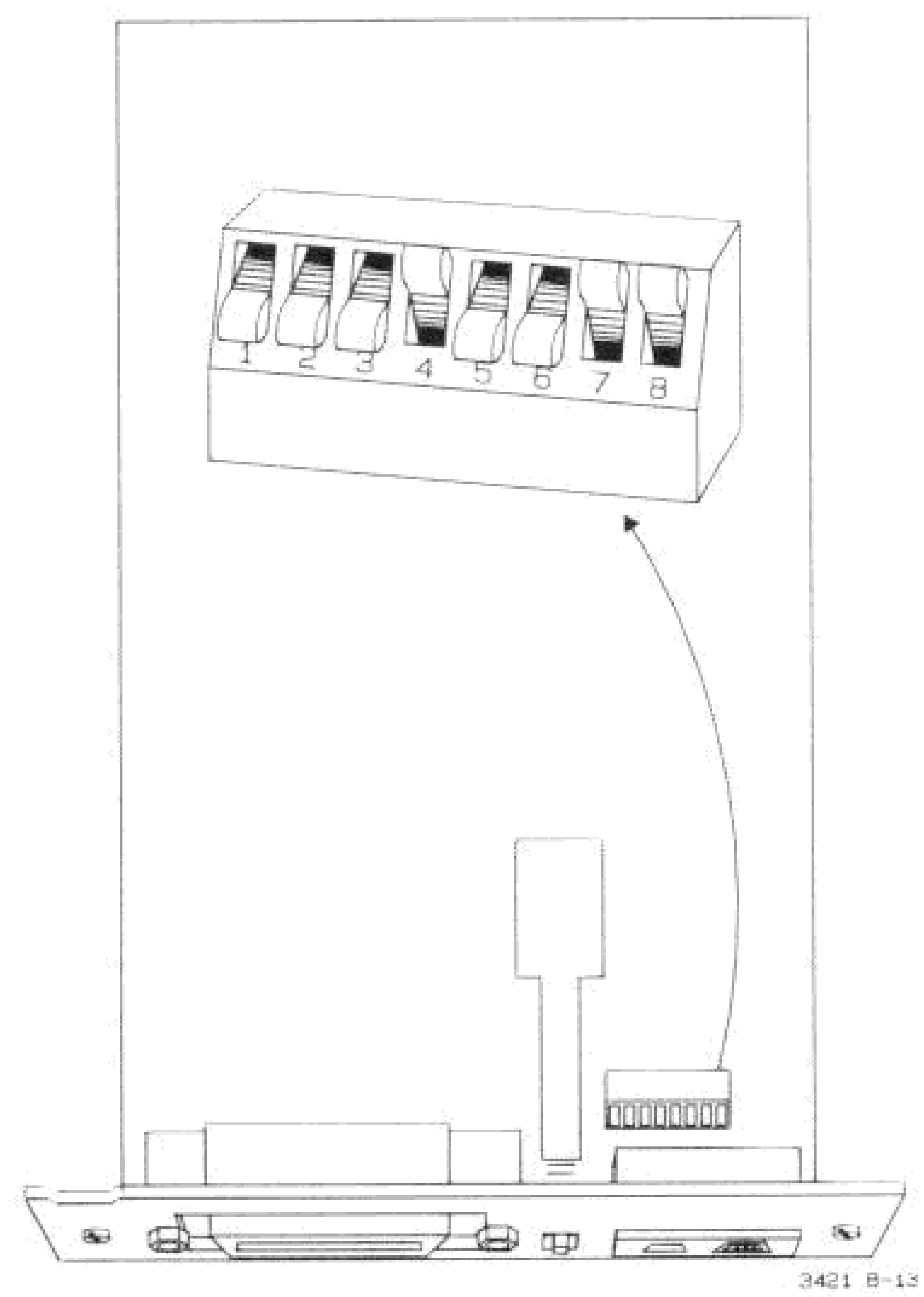



**Figure 4-8-13. S802 Switch Settings for Signatures in Table 4-8-6**

**Table 4-8-6. Signatures for Figure 4-8-13 Switch Settings (SA test #1)**

S802(4,7,8) away from the board
S802(1-3,5,6) toward the board

+5V Signature: F7H0

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| Port 10 | Data Bit 1 | U804(27) | FF0C | U806(18),U807(18), U808(18),U809(3), U810(14) |
| Port 11 | Data Bit 2 | U804(28) | 721C | U806(16),U807(16), U808(16),U809(4), U810(13) |
| Port 12 | Data Bit 3 | U804(29) | 14PU | U806(14),U807(14), U808(14),U809(7), U810(12) |
| Port 13 | Data Bit4 | U804(30) | 288H | U806(12),U807(12), U808(12),U809(8), U810(11) |
| Port 14 | Data Bit 5 | U804(31) | 66A9 | U806(9),U807(9), U808(9),U809(13), U811(14) |
| Port 15 | Data Bit 6 | U804(32) | H1U2 | U806(7),U807(7), U808(7),U809(14), U811(13) |

f. Set the S802 switch segments as shown in Figure 4-8-14 and check for the signatures listed in Table 4-8-7. If any signature is incorrect, refer to paragraph 4-8-71 to isolate the defective area. If all signatures are correct, proceed with step g.

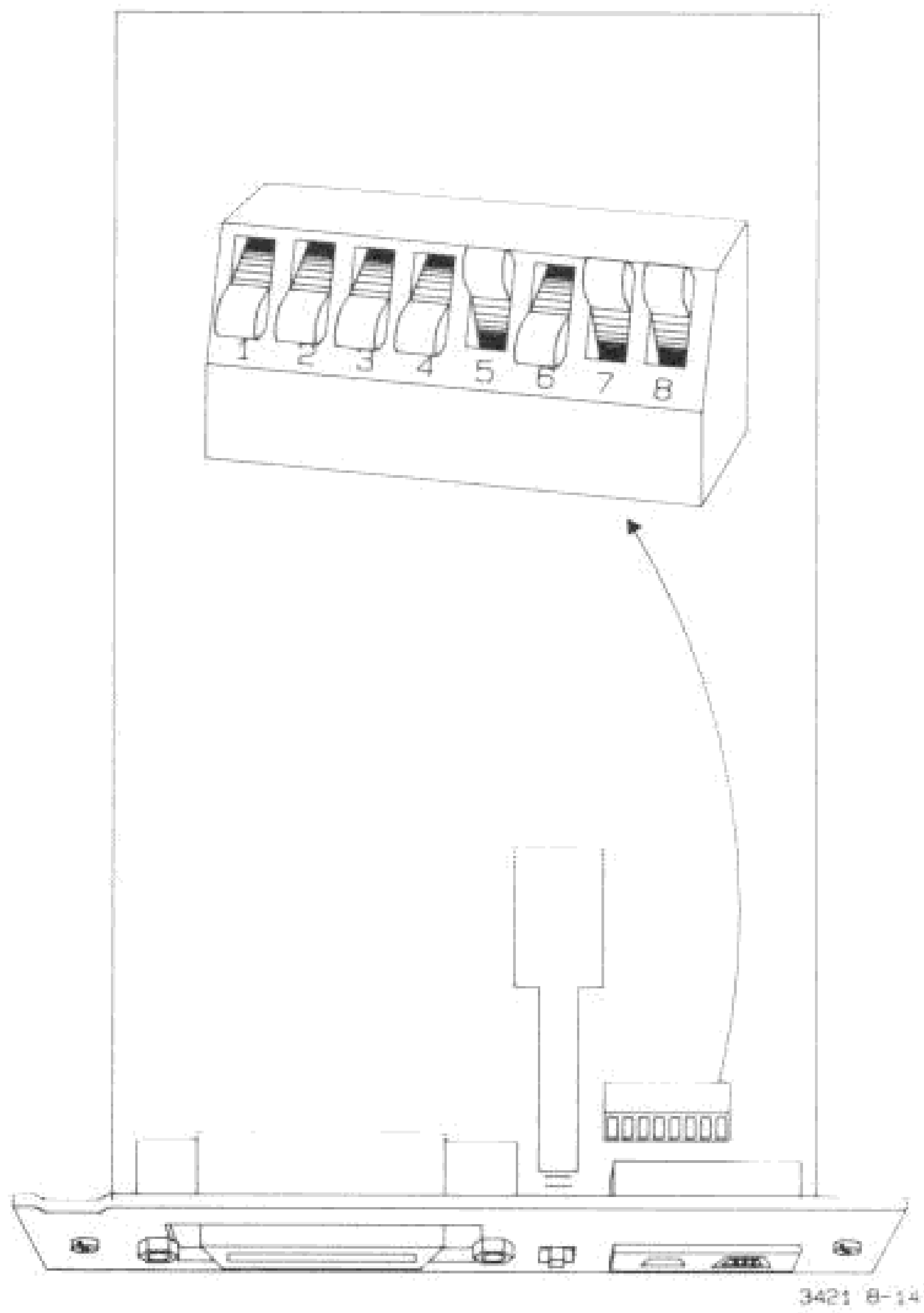



**Figure 4-8-14. S802 Switch Settings for Signatures in Table 4-8-7**

**Table 4-8-7. Signatures for Figure 4-8-14 Switch Settings (SA Test #1)**

S802(5,7,8) away from the board
S802(1-4,6) toward the board

+5V Signature: F7H0

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| Port 10 | Data Bit 1 | U804(27) | FF0C | U806(18),U807(18), U808(18),U809(3), U810(14) |
| Port 11 | Data Bit 2 | U804(28) | 721C | U806(16),U807(16), U808(16),U809(4), U810(13) |
| Port 12 | Data Bit 3 | U804(29) | 14PU | U806(14),U807(14), U808(14),U809(7), U810(12) |
| Port 13 | Data Bit 4 | U804(30) | 854C | U806(12),U807(12), U808(12),U809(8), U811(11) |
| Port 14 | Data Bit 5 | U804(31) | FC6U | U806(9),U807(9), U808(9),U809(13), U811(14) |
| Port 15 | Data Bit 6 | U804(32) | H1U2 | U806(7),U807(7), U808(7),U809(14), U811(13) |

g. Set the S802 switch segments as shown in Figure 4-8-15 and check for the signatures listed in Table 4-8-8. If any signature is incorrect, refer to paragraph 4-8-71 to isolate the defective area. If all signatures are correct, assume that the HP-IB board is operating correctly. If, however, the board still appears to be operating improperly, there is slight a possibility that a failure exists with the internal CPU RAM that was not detected by SA Test #1.

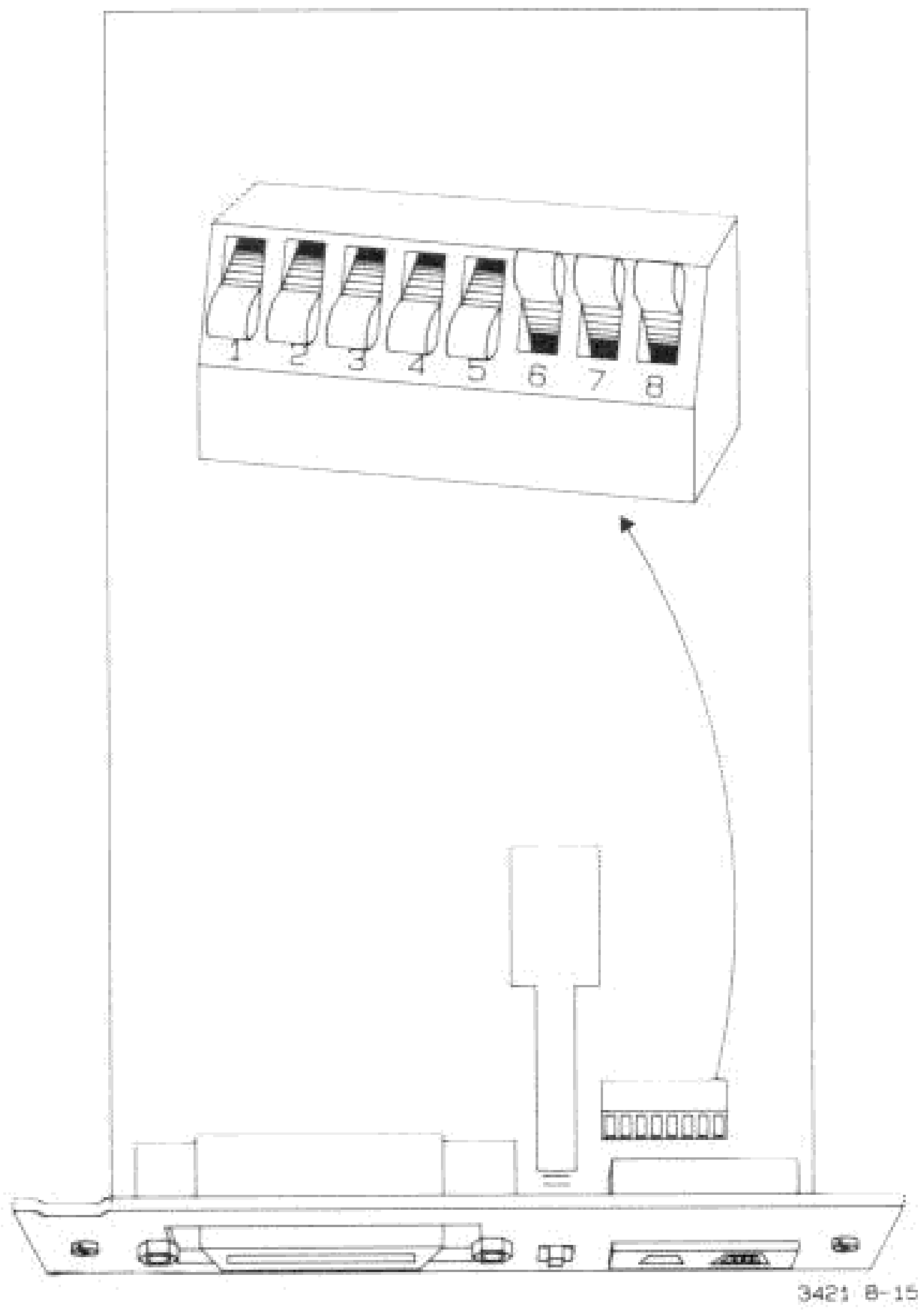



**Figure 4-8-15. S802 Switch Settings for Signatures in Table 4-8-8**

**Table 4-8-8. Signatures for Figure 4-8-15 Switch Settings (SA test #1)**

S802(6-8) away from the board
S802(1-5) toward the board

+5V Signature: F7H0

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| Port 10 | Data Bit 1 | U804(27) | FF0C | U806(18),U807(18), U808(18),U809(3), U810(14) |
| Port 11 | Data Bit 2 | U804(28) | 721C | U806(16),U807(16), U808(16),U809(4), U810(13) |
| Port 12 | Data Bit 3 | U804(29) | 14PU | U806(14),U807(14), U808(14),U809(7), U810(12) |
| Port 13 | Data Bit 4 | U804(30) | 854C | U806(12),U807(12), U808(12),U809(8), U810(11) |
| Port 14 | Data Bit 5 | U804(31) | 66A9 | U806(9),U807(9), U808(9),U809(13), U811(14) |
| Port 15 | Data Bit 6 | U804(32) | 7F34 | U806(7),U807(7), U808(7),U809(14), U811(13) |

**4-8-71. Isolating an Incorrect S802 Signature.** If an incorrect S802 signature was found in Table 4-8-3 through 4-8-8, use this procedure to isolate the failure. It is unnecessary to perform this procedure if all those signatures were correct.

4-8-72. Figure 4-8-16 shows a schematic representation of S802 and its associated circuitry. The switch segment positions illustrated correspond to the switch settings of Figure 4-8-10 and the signatures listed in Table 4-8-3. In this configuration, switch segment 1 (pin 1 and 16) is open (away from the pc board) and switch segments 2 through 6 are closed (toward the pc board). This is the only switch setting that is illustrated. Therefore, if the incorrect signature was found with the switch segment set differently, you must modify the procedure accordingly.

4-8-73. Perform the following procedure to isolate a failure in the switch circuitry.

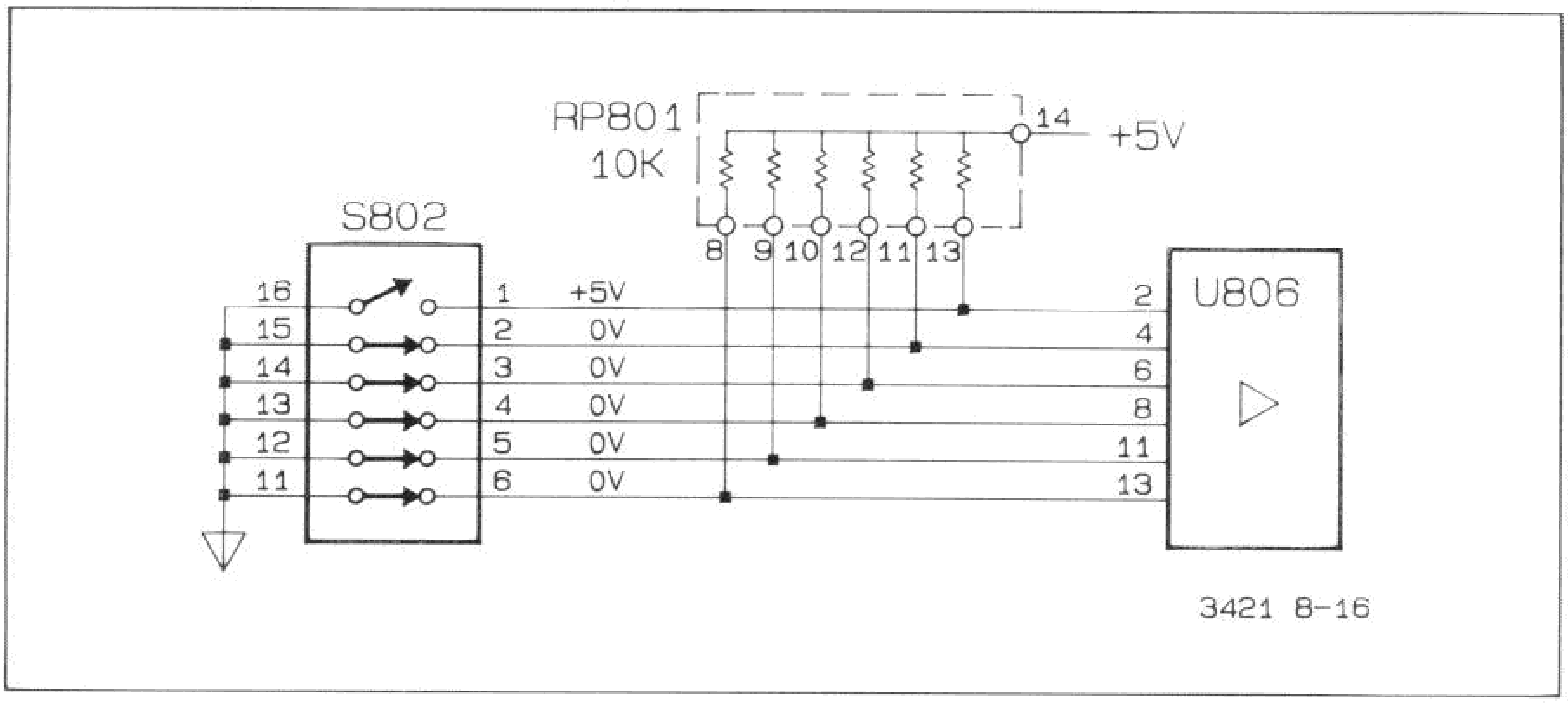



**Figure 4-8-16. Checking the S802 Circuitry**

a. Make sure the HP 3421A front panel switch is on and the rear panel HP-IB/HP-IL switch is in the HP-IB position (in).

b. Refer to Figure 4-8-16 and check for +5V at U806 pin 2. If the voltage is correct, proceed with step c. If incorrect, check S802 pin 1 (square pad on circuit side of board) for +5V. If the voltage is correct, either the trace between RP801 pin 13 and U802 pin 2 is open, or RP801 is defective.

c. Check U806 pins 4, 6, 8, 11, and 13 for a ground level. If they are correct, the switch circuitry is good. If one or more is incorrect, do the following:

1. Identify the line that is incorrect and check it at the output of S802 for a ground level. For example, if U806 pin 4 was incorrect, check S802 pin 2 for a ground level. If the line is at the ground level at the output of S802, the trace going to U806 is open. If still incorrect, proceed with step 2.

2. Check the grounded input of S802 on the line that is incorrect. For example, if S802 pin 2 is wrong, check S802 pin 15 for a ground level. If the input to the switch is wrong, the trace to that pin is probably open or the pin is not soldered properly.

### 4-8-74. SA Test #2 (HP-IL Troubleshooting)

4-8-75. Run this test to isolate the defective component if an incorrect HP-IL signature was found in SA Test #1. Otherwise, it is not necessary to run this test.

4-8-76. Perform the following procedure to run SA Test #2.

a. Press the rear panel HP-IB/HP-IL switch (S801) to the HP-IL position (out).

b. Refer to Figure 4-8-17 and set the switch segment of S802 as follows:

segments 1-7 toward the pc board (closed)
segment 8 away from the pc board (open)

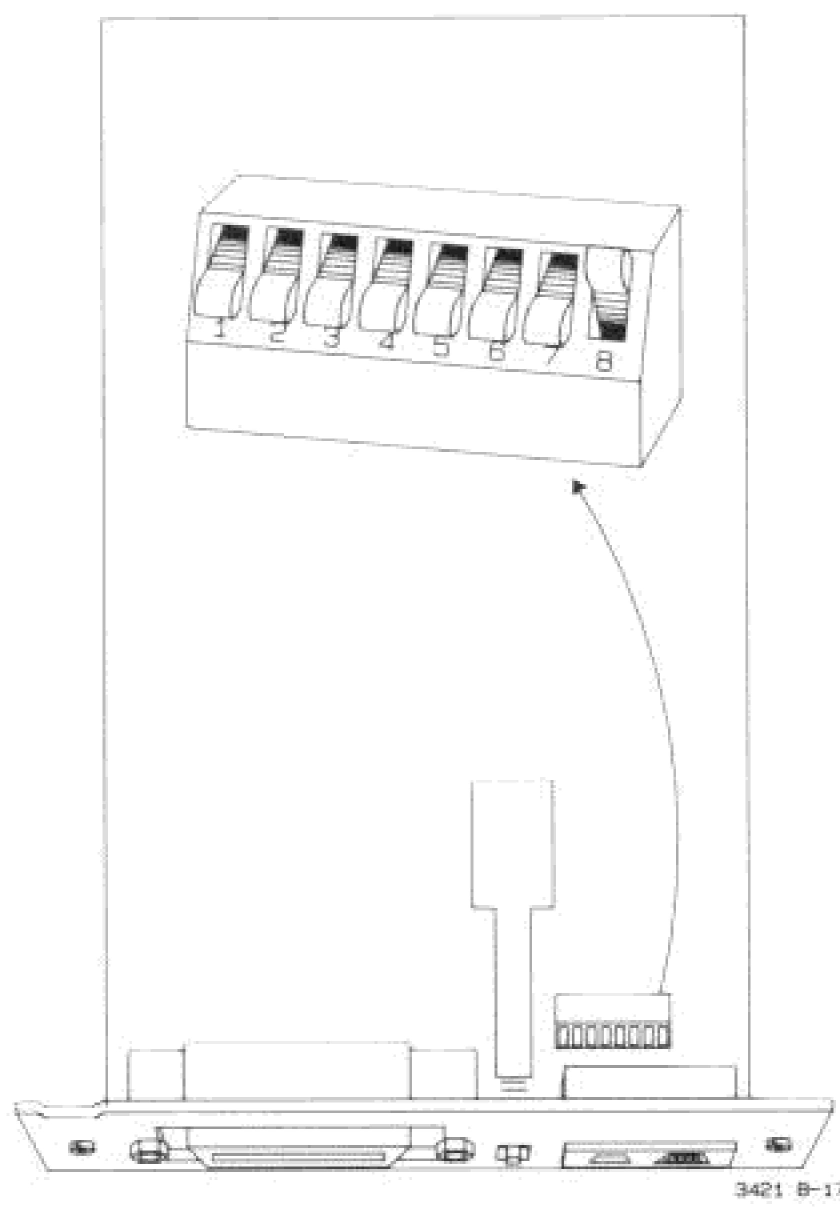



**Figure 4-8-17. S802 Switch Settings for SA Test #2**

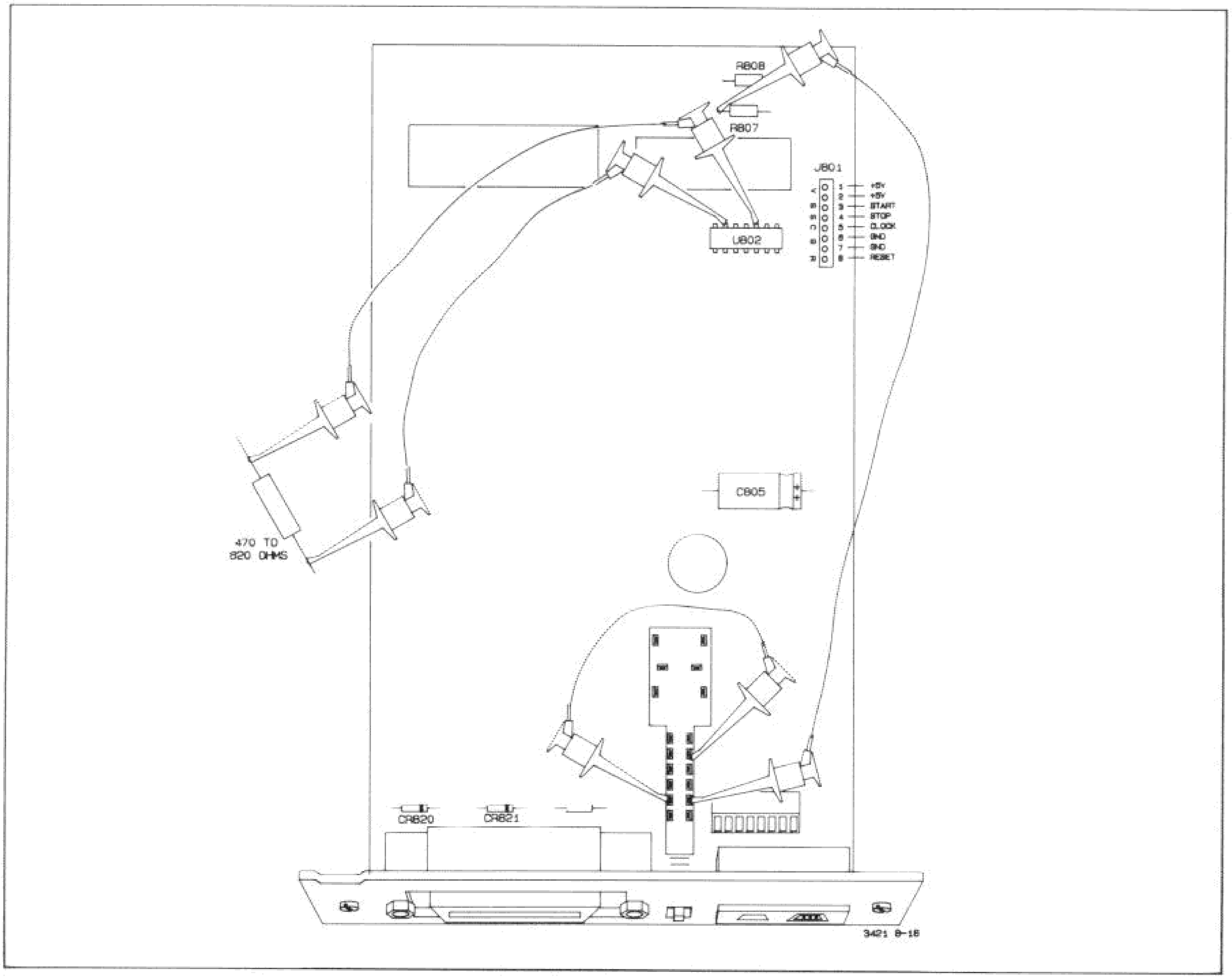



**Figure 4-8-18. Jumper Configuration for SA Test #2**

c. Refer to Figure 4-8-18 and perform the following jumper configuration.

1. Use a cliplead jumper and connect S801 lug 5 to S801 lug 17.

2. Connect a cliplead jumper between S801 lug 2 and the side of R807 shown.

3. Locate a 4700Ω to 6200Ω resistor with a rating of 1/8W or greater and connect between pins 3 and 6 of U802 as shown. It may be easier to use an IC clip rather than make jumper connections directly to the IC pins.

d. Set the signature analyzer as follows:

| | | |
|---|---|---|
| START | = | (out) |
| STOP | = | (out) |
| CLOCK | = | (out) |

e. Connect the signature analyzer as follows:

START to J801 pin 3
STOP to J801 pin 4
CLOCK to U804 pin 10 or U803 pin 27
GND to J801 pin 6 or 7

f. Make sure the HP 3421A front panel switch is on.

g. Press the rear panel HP-IB/HP-IL switch (S801) to the HP-IB position (in). This powers up the HP-IB assembly.

h. The +5V signature displayed on the signature analyzer should be 007U. If the +5V signature is correct, proceed with step i. If the signature is incorrect, either your setup is wrong or the CPU (U804) is defective. Since the operation of the CPU should have been verified in SA Test #1, your setup is probably incorrect,

i. Check the signatures in Table 4-8-9. With this setup, the CPU (U804) is writing to the HP-IL chip (U803). If an incorrect signature is found, check the line between U803 and U804 to make sure it is not open or shorted to another circuit location. If all the signatures are correct, proceed with step j.

**Table 4-8-9. HP-IL Signatures (U804 Write)**

S802(1-7) toward the board
S802(8) away from the board

+5V Signature: 007U

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D0 | Data Bit | U803(14) | 0020 | U804(12) |
| D1 | Data Bit | U803(13) | 001U | U804(13) |
| D2 | Data Bit | U803(12) | 0020 | U804(14) |
| D3 | Data Bit | U803(11) | 001U | U804(15) |
| D4 | Data Bit | U803(9) | 0020 | U804(16) |
| D5 | Data Bit | U803(8) | 0040 | U804(17) |
| D6 | Data Bit | U803(7) | 001U | U804(18) |
| D7 | Data Bit | U803(6) | 0060 | U804(19) |
| RS0 | CPU RAM 0 Address Line | U803(4) | 003U | U804(22) |
| RS1 | CPU RAM Address 1 Line | U803(5) | 0040 | U804(21) |
| RS2 | CPU RAM Address Line | U803(3) | 001U | U804(23) |

j. Connect the signature analyzer clock to U804 pin 8 or U803 pin 26. With this configuration, U803 is writing to U804.

k. Verify the signatures in Table 4-8-10. Check the signature at U803 pin 12 first. This verifies if your setup is correct. If all the signatures are correct and all the signatures in Table 4-8-9 were correct, the HP-IL circuitry on the HP-IB assembly is operational. If any signature is wrong, proceed with step l.

**Table 4-8-10. HP-IL Signatures (U803 Write)**

S802(1-7) toward the board
S802(8) away from the board

+5V Signature: F7H0

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| D2 | Data Bit | U803(12) | 0060* | U804(14) |
| D0 | Data Bit | U803(14) | 0060 | U804(12) |
| D1 | Data Bit | U803(13) | 001U | U804(13) |
| D3 | Data Bit | U803(11) | 001U | U804(15) |
| D4 | Data Bit | U803(9) | 0020 | U804(16) |
| D5 | Data Bit | U803(8) | 0040 | U804(17) |
| D6 | Data Bit | U803(7) | 001U | U804(18) |
| D7 | Data Bit | U803(6) | 0060 | U804(19) |
| RS0 | CPU RAM 0 Address Line | U803(4) | 003U | U804(22) |
| RS1 | CPU RAM Address 1 Line | U803(5) | 0040 | U804(21) |
| RS2 | CPU RAM Address Line | U803(3) | 001U | U804(23) |

* If this signature is 0020, there is an open in the HP-IL loop. This is most likely caused by an incorrect placement of one or more of the jumpers.

l. Make sure all jumpers are still connected between R807 and S801 pin 2, and between S801 pin 5 and S801 pin 17. Also make sure the 470Ω-620Ω resistor is connected between U802 pin 3 and U802 pin 6. The jumpers and resistors were put in place in a previous step. The signature analyzer is not needed in this procedure and may be disconnected if desired.

m. Set a dual trace oscilloscope to 5μS/div sweep time and 2V/div vertical gain. Invert channel B of the oscilloscope. With the oscilloscope probes referenced to ground on the HP-IB assembly, check U803 pin 19 and 20, and then U803 pin 18 and 17 for the waveforms shown in Figure 4-8-19. To obtain the waveform shown in the figure, the HP-IB assembly must be running SA Test #2. Also, the jumpers are configured to simulate an HP-IL loop connection. Hence, the waveforms at U803 pins 17 and 18 are generated as a result of the waveforms at U803 pins 19 and 20. If the waveforms are missing or incorrect, do the following:

1. Check switch S802 for the following configuration:

   segments 1-7 toward the pc board (closed)
   segment 8 away from the pc board (open)

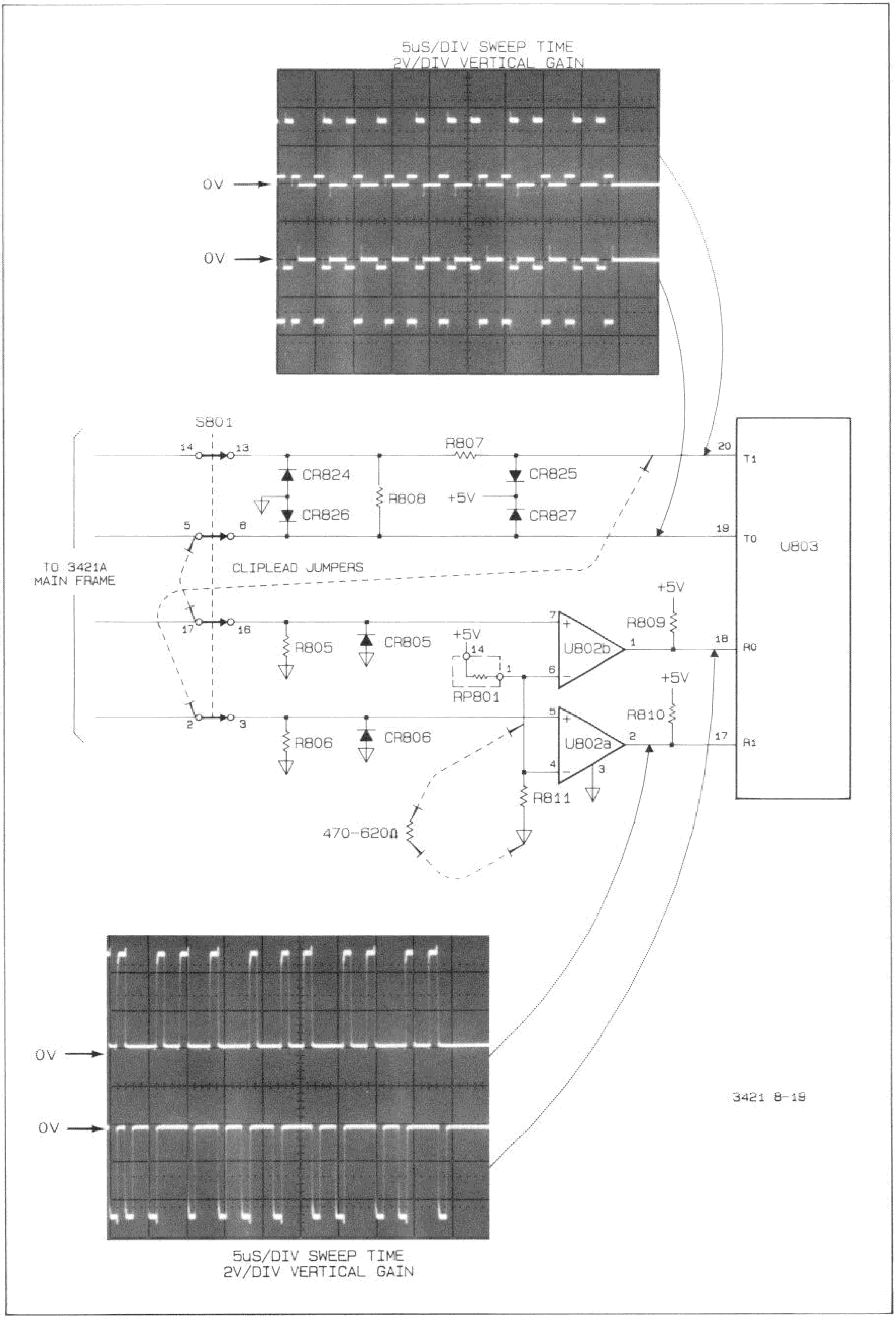



**Figure 4-8-19. HP-IL Waveforms (SA Test #2)**

2. Cycle power on the HP-IB assembly by pressing the rear panel HP-IB/HP-IL switch to HP-IL and back to the HP-IB position. This ensures that the HP-IB assembly is running SA Test #2.

3. Check for the waveforms at U803 pins 19 and 20. If these are missing or incorrect, U803 is probably defective.

4. If the waveforms at U803 pins 19 and 20 are good, but the waveforms at U803 pins 17 and 18 are incorrect or missing, suspect U802 or S801. Keep in mind that the failure could also be caused by any component associated with the defective line.

#### 4-8-77. SA Test #3 (HP-IB Troubleshooting)

4-8-78. Run this test to isolate the defective component if any incorrect HP-IB signature was found in SA Test #1. Otherwise, this test is not necessary.

4-8-79. Perform the following procedure to run the test.

a. Press the rear panel HP-IB/HP-IL switch (S801) to the HP-IL position (out).

b. Refer to Figure 4-8-20 and set the switch segments of S802 as follows:

segments 1-6 and 8 toward the pc board (closed)
segment 7 away from the pc board (open)

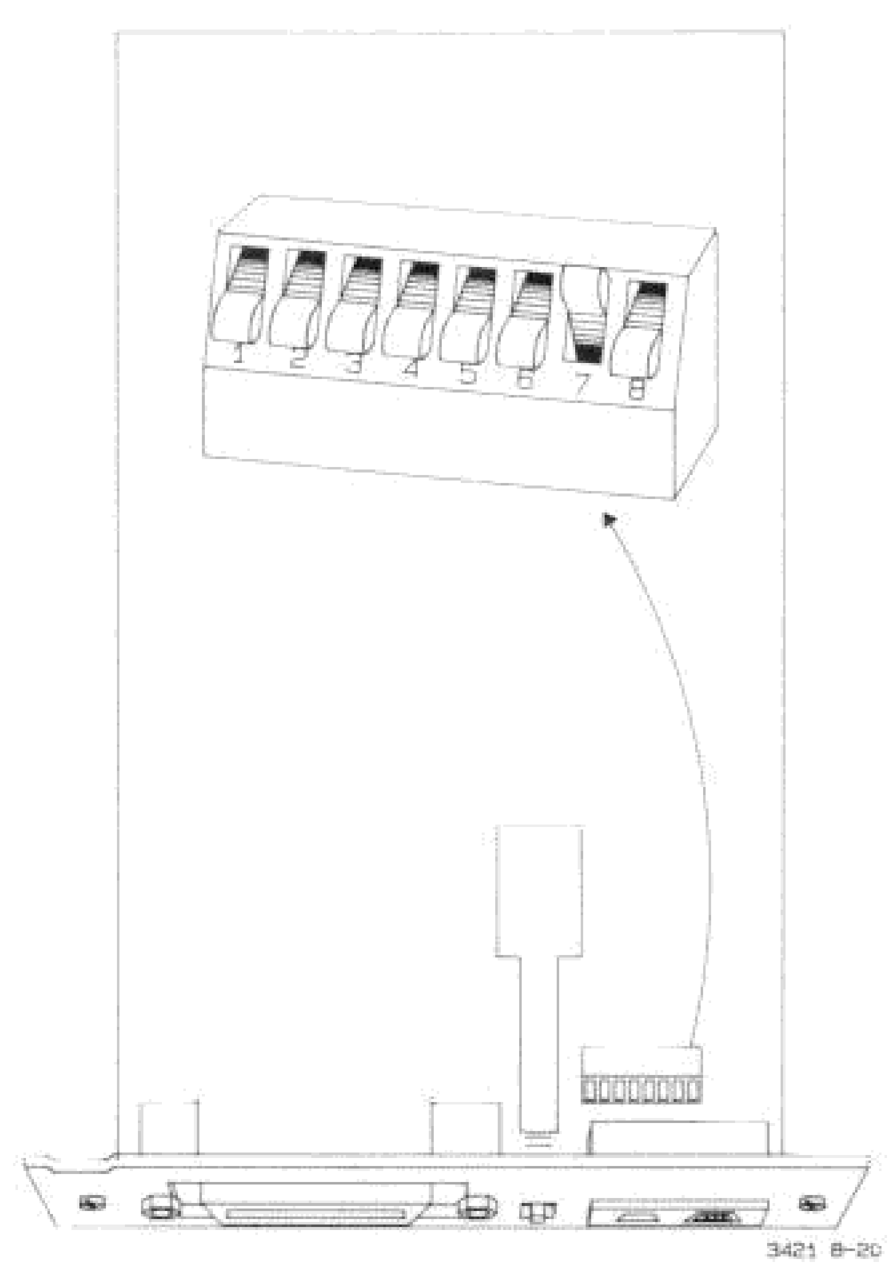



**Figure 4-8-20. S802 Switch Settings for SA Test #3**

c. Set the signature analyzer as follows:

START = _/‾ (out)

STOP = _/‾ (out)

CLOCK = _/‾ (out)

d. Connect the signature analyzer as follows:

START to J801 pin 3
STOP to J801 pin 4
CLOCK to J801 pin 5
GND to J801 pin 6 or 7

e. Refer to Figure 4-8-21 and connect the cathode of CR821 to the negative side of C805.

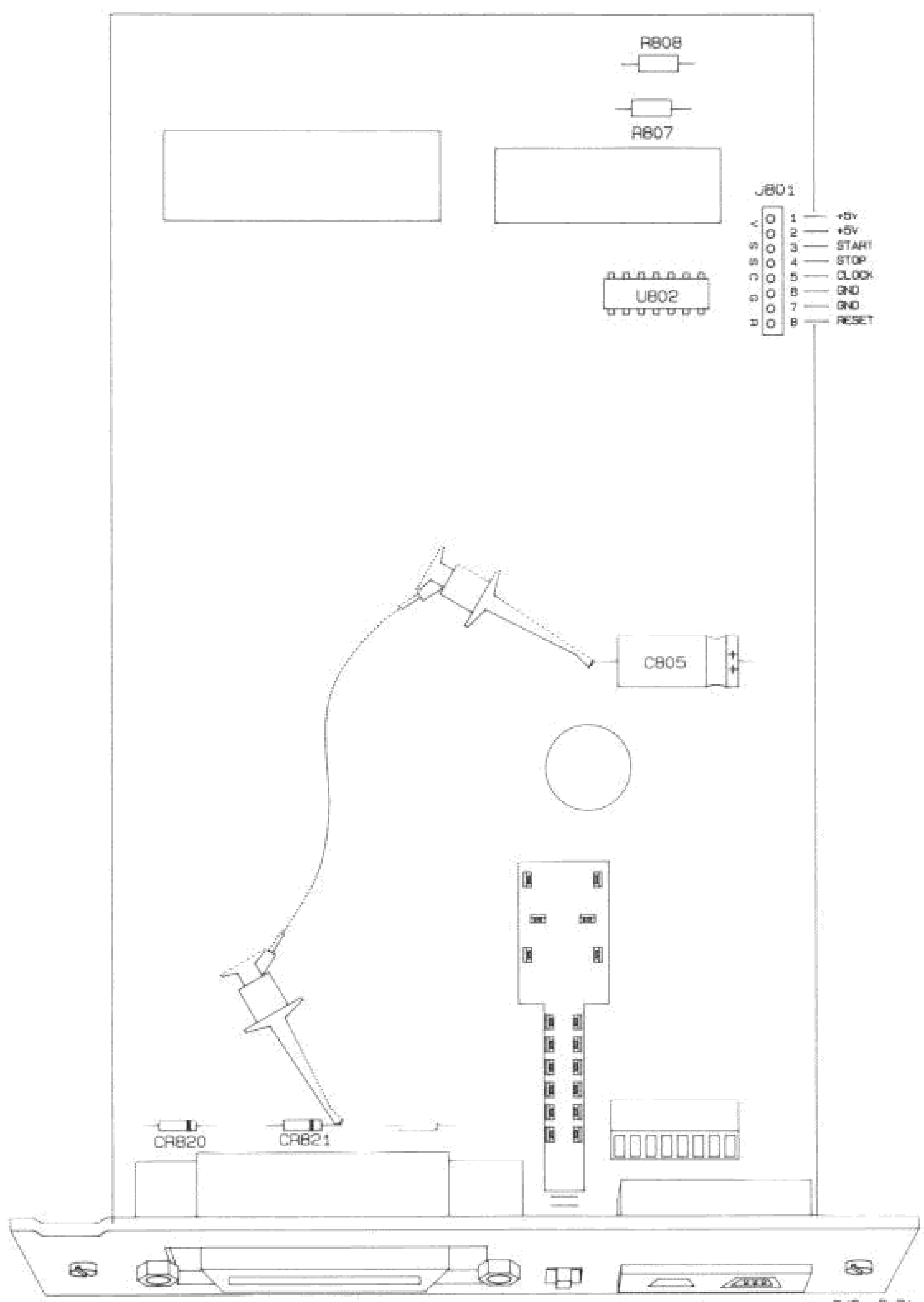



**Figure 4-8-21. Jumper Configuration for SA Test #3**

f. Press the rear panel HP-IB/HP-IL switch to the HP-IB position (in). This powers up the HP-IB assembly.

g. The +5V signature displayed on the signature analyzer should be 7C97. If this signature is wrong, make sure the signature analyzer is properly connected.

h. Verify the signatures in Table 4-8-11. If any signature is incorrect, replace U804. If all signatures are correct, proceed with step i.

**Table 4-8-11. HP-IB U804 Signatures**

S802(1-6,8) toward the board
S802(7) away from the board

+5V Signature: 7C97

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| — | Control | U804(38) | 8787 | U805(1) |
| — | Control | U804(37) | 1A1F | U805(15) |
| — | Control | U804(36) | 1P5C | U805(3,13) |
| — | Control | U804(35) | 5115 | U805(2,14) |

i. Verify the signatures in Table 4-8-12. If any signature is incorrect, U804 is probably defective. If all signatures are correct, proceed with step j.

**Table 4-8-12. HP-IB U805 Signatures**

S802(1-6,8) toward the board
S802(7) away from the board

+5V Signature: 7C97

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| RSW | Enable Line for U806 | U805(6) | 7C60 | U806(1,19) |
| RCTL | Enable Line for U808 | U805(5) | P2P9 | U808(1,19) |
| RDATA | Enable Line for U807 | U805(4) | 1P0P | U807(1,19) |
| WCTRL | Clock for U810 and U811 | U805(11) | 48UP | U810(7),U811(7) |
| WDATA | Clock for U809 | U805(12) | 2975 | U809(11) |

j. Move the signature analyzer clock to U805 pin 5.

k. The +5V signature should be 6680. If it is incorrect, check your setup. If it is correct, proceed with step l.

l. Verify the signatures in Table 4-8-13. If all signatures are correct, proceed with step m. If any signature is incorrect, suspect the IC that sources the signature.

**Table 4-8-13. HP-IB U810 and U811 Signatures**

S802(1-6,8) toward the board
S802(7) away from the board

+5V Signature: 6680

| Mnemonic | Function | Check At | Signature | Also Appears At |
|---|---|---|---|---|
| – | Control | U810(6) | 0H42 | U815(11) |
| – | Control | U810(5) | PH96 | U815(8) |
| – | Control | U810(4) | 96U3 | – |
| – | Control | U810(3) | HH8A | – |
| – | Control | U811(6) | 58A5 | – |
| – | Control | U811(5) | PH96 | U816(8) |
| – | Control | U811(3) | 5113 | U815(14) |

m. Refer to Figure 4-8-22 and check pin 10 of the rear panel HP-IB connector (J806) for a signature of 3P25. The rear panel HP-IB connector is illustrated upside down as this is the way it should be positioned on your work surface. If this signature is correct, proceed with step n. If it is incorrect, check Q803 and associated components.

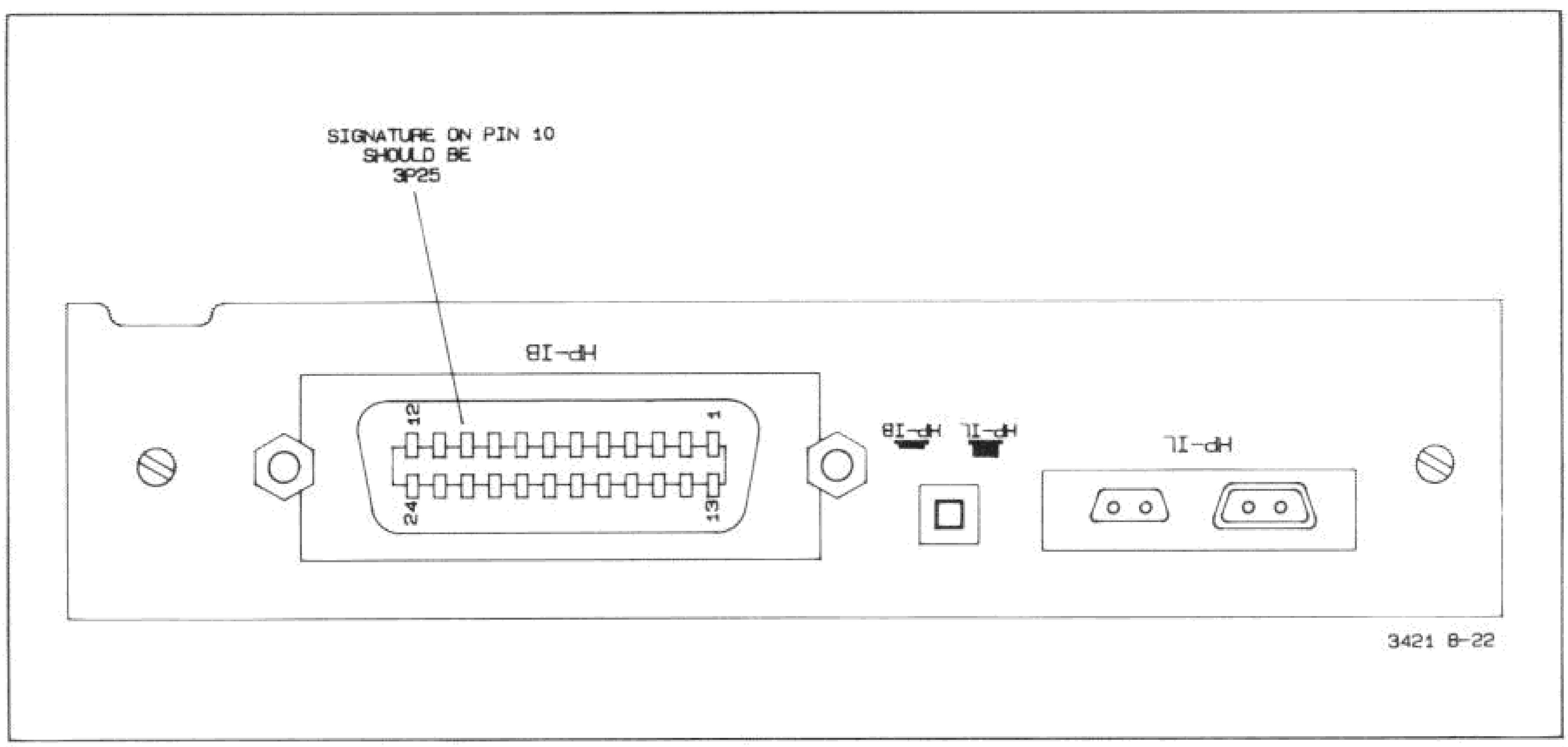



**Figure 4-8-22. J806 Pin 10 Signatures (SA Test #3)**

n. Verify the signatures in Table 4-8-14 in the given order. If they are all correct, proceed to step o. If any signature is incorrect, replace the component listed in the table. For this setup, ATN is floating and REN is grounded.

## Table 4-8-14. HP-IB Control/Handshake Signatures with ATN Floating and REN Grounded

S802(1-6,8) toward the board
S802(7) away from the board

+5V Signature: 6680

| Mnemonic | Function | Check At | Signature | Also Appears At | Suspect Part If Signature Is Wrong |
|---|---|---|---|---|---|
| — | Control | U812(10) | 0000(GND) | U808(15) | U812 |
| — | Control | U814(8) | 6680(+5V) | U816(9) | U814 |
| — | Handshake | U815(15) | 3793 | U816(12) | U815 |
| — | Handshake | U816(11) | 6680(+5V) | U816(6) | U816 |
| — | Control | U816(10) | 8C16 | U809(1),U817(2), U817(5) | U816 |
| — | Handshake | U815(6) | U073 | U816(5) | U815 |
| — | Control | U815(10) | 8C16 | U817(6) | U815 |
| — | Control | U815(12) | 6CF2 | U817(1) | U815 |
| — | Handshake | U816(4) | 96U3 | — | U816 |
| — | Handshake | U817(4) | PH96 | — | U817 |
| — | Control | U817(3) | 9402 | — | U817 |
| — | Handshake | U812(1) | CC0A | U820(8),J806(7) | U820,CR816, R843,R835 |
| — | Handshake | U812(3) | U073 | U820(7),J806(8), RP803(13),RP804(1) | U820,CR817, RP803,J806 RP804,J806 |
| — | Handshake | U812(5) | 8C16 | U820(14),RP803(1), RP804(13) | U820,CR818 RP803,RP804, J806 |
| — | Control | U812(9) | U282 | U820(1),RP803(12), RP804(2) | U820,CR819, RP803,RP804, J806 |
| | Control | U812(13) | 0000(GND) | Grounded For This Setup | — |
| — | Handshake | U812(2) | HH8A | U808(2),RP802(11) | U812 |
| — | Handshake | U812(4) | 96U3 | U808(4),RP802(12) | U812 |
| — | Control | U812(6) | PH96 | U808(6),RP802(13) | U812 |
| — | Control | U812(8) | 9402 | U808(8),RP802(9) | U812 |
| — | Control | U812(12) | 6680(+5V) | U808(15) | U812 |
| — | Control | U804(34) | 0000f | U806(3),U807(3), U808(3),U809(18), U811(11) | U808 |
| — | Control | U804(33) | 6680f | U806(5),U807(5), U808(5),U809(17), U811(12) | U808 |
| — | Control | U804(32) | 0000f | U806(7),U807(7), U808(7),U809(14), U811(13) | U808 |
| — | Control | U804(31) | 0000f | U806(9),U807(9), U808(7),U809(13), U811(14) | U808 |
| — | Control | U804(30) | 9402 | U806(12),U807(12), U808(12),U809(8), U810(11) | U808 |
| — | Handshake | U804(29) | PH96 | U806(14),U807(14), U808(14),U809(7), U810(12) | U808 |
| — | Handshake | U804(28) | 96U3 | U806(16),U807(16), U808(16),U809(4), U810(13) | U808 |
| — | Handshake | U804(27) | HH8A | U806(18),U807(18), U808(18),U809(3), U810(14) | U808 |

f indicates that the probe tip should be flashing

o. Move the cliplead jumper from the cathode of CR821 to the cathode of CR820. The other end of the cliplead jumper is grounded. With this configuration, ATN is grounded and REN is floating.

p. Verify the signatures in Table 4-8-15 in the given order. If they are all correct, proceed to step q. If any signature is incorrect, replace the component listed in the table.

**Table 4-8-15. HP-IB Control/Handshake Signatures with ATN Grounded and REN Floating**

S802(1-6,8) toward the board
S802(7) away from the board

+5V Signature: 6680

| Mnemonic | Function | Check At | Signature | Also Appears At | Suspect Part If Signature Is Wrong |
|---|---|---|---|---|---|
| — | Control | U812(10) | 6680(+5V) | U808(15) | U812 |
| — | Control | U814(8) | 000(GND) | U816(9) | U814 |
| — | Handshake | U816(11) | 5113 | U816(6) | U816 |
| — | Control | U816(10) | 6680(+5V) | U809(1),U817(2), U817(5) | U816 |
| — | Handshake | U816(4) | 2385 | — | U816 |
| — | Handshake | U817(4) | 0000(GND) | — | U817 |
| — | Control | U817(3) | 0000(GND) | — | U817 |
| — | Handshake | U812(3) | 4505 | U820(7),J806(8), RP803(13),RP804(1) | U820,CR817, RP803,J806 RP804,J806 |
| — | Handshake | U812(5) | 6680(+5V) | U820(14),RP803(1), RP804(13) | U820,CR818 RP803,RP804, J806 |
| — | Control | U812(9) | 6680(+5V) | U820(1),RP803(12), RP804(2) | U820,CR819, RP803,RP804, J806 |
| — | Control | U812(13) | 6680(+5V) | Floating For This Setup | U812 |
| — | Handshake | U812(4) | 2385 | U808(4),RP802(12) | U812 |
| — | Control | U812(6) | 0000(GND) | U808(6),RP802(13) | U812 |
| — | Control | U812(8) | 0000(GND) | U808(8),RP802(9) | U812 |
| — | Control | U812(12) | 0000(GND) | U808(15) | U812 |
| — | Control | U804(34) | 0000f | U806(3),U807(3), U808(3),U809(18), U811(11) | U808 |
| — | Control | U804(33) | 0000f | U806(5),U807(5), U808(5),U809(17), U811(12) | U808 |
| — | Control | U804(32) | 0000f | U806(7),U807(7), U808(7),U809(14), U811(13) | U808 |
| — | Control | U804(31) | 6680f | U806(9),U807(9), U808(7),U809(13), U811(14) | U808 |
| — | Control | U804(30) | 0000f | U806(12),U807(12), U808(12),U809(8), U810(11) | U808 |
| — | Handshake | U804(29) | 0000f | U806(14),U807(14), U808(14),U809(7), U810(12) | U808 |
| — | Handshake | U804(28) | 2385 | U806(16),U807(16), U808(16),U809(4), U810(13) | U808 |
| — | Handshake | U804(27) | HH8A | U806(18),U807(18), U808(18),U809(3), U810(14) | U808 |

f indicates that the probe tip should be flashing

q. Move the signature analyzer clock to U805 pin 4.

r. Move the cliplead jumper from the cathode of CR820 to the cathode of CR821. The other end of the cliplead jumper is grounded.

s. The +5V signature displayed on the signature analyzer should be 6680.

t. Verify the signatures in Table 4-8-16 in the given order. If all signatures are correct, the HP-IB portion of the circuitry is operational. If any signature is wrong, replace the part identified in the table.

## 4-8-80. +5V POWER SUPPLY TROUBLESHOOTING

4-8-81. When troubleshooting the +5V power supply on the HP-IB option, make sure your test instrument is referenced to the correct ground (see Figure 4-8-23). The optoisolator (U801) and transformer (T801) isolate the two grounds. Use the ground on the HP-IB option when checking components associated with the secondary of T801. This includes U801 pins 2 and 3. Use the HP 3421A mainframe ground when checking all remaining components.

4-8-82. Voltage VB is used to power the +5V power supply. Therefore, make sure VB is applied to the HP-IB assembly when troubleshooting the +5V power supply. VB is applied when the rear panel HP-IB/HP-IL switch is placed in the HP-IB position while the front panel switch is on. If the HP-IB/HP-IL switch is in the HP-IL position, VB is removed from the HP-IB assembly.

### 4-8-83. Troubleshooting Tips

4-8-84. The following paragraphs list some things to look for when certain failures occur. Figure 4-8-23 shows the voltages and waveforms to expect when the +5V power supply is operating properly.

**4-8-85. Output Voltage Too High.** When the output voltage (+5V) is greater than 5.25Vdc, suspect a problem in the feedback loop. A feedback loop problem will most likely be caused by U801 or CR803. To check U801, make sure that the voltages listed for the various pins are correct, especially the voltage at U801 pin 5. If the voltage at pin 5 is more negative than −14Vdc, U801 is probably defective. If pin 5 is more positive than −7Vdc, the problem could be U801, CR801, or C804. The voltage at U801 pin 5 should be between −7Vdc and −14Vdc for U801 to provide the proper feedback, and can vary between these limits with changes in VB and U801 component variations.

4-8-86. When checking CR803, expect to measure a cathode to anode voltage differential of about 4.1Vdc, NOT 3.6Vdc. CR803 is rated at 3.6V at 300 $\mu$A. In this circuit application, however, the current through CR803 is approximately 1 mA, which causes the voltage across CR803 to be about 4.1Vdc.

**4-8-87. Output Voltage Too Low.** This type of problem could be caused by several circuit components, including a low impedance path across the output of the supply. Make sure that VB is between 5.8 Vdc and 7.6Vdc. Also check U801 pin 5 to make sure it has a negative voltage of at least −7 Vdc. If U801 pin 5 is more positive than −7V, suspect U801 or C804. If none of the preceding items seem to be the problem, check the remaining voltages and waveforms.

## Table 4-8-16. HP-IB Data Signatures

S802(1-6,8) toward the board
S802(7) away from the board

+5V Signature: 6680

| Mnemonic | Function | Check At | Signature | Also Appears At | Suspect Part If Signature Is Wrong |
|---|---|---|---|---|---|
| — | Data Bit 1 | U809(2) | HH8A | | U809 |
| — | Data Bit 2 | U809(5) | 96U3 | — | U809 |
| — | Data Bit 3 | U809(6) | PH96 | — | U809 |
| — | Data Bit 4 | U809(9) | 0H42 | — | U809 |
| — | Data Bit 5 | U809(12) | 5113 | — | U809 |
| — | Data Bit 6 | U809(15) | PHP0 | — | U809 |
| — | Data Bit 7 | U809(16) | FU39 | — | U809 |
| — | Data Bit 8 | U809(19) | 58A5 | — | U809 |
| DIO1 | Data Bit 1 | U813(1) | CC0A | U818(8),RP803(9), RP804(5),J806(1) | U818,CR808, RP803 |
| DIO2 | Data Bit 2 | U813(3) | U073 | U818(7),RP803(8), RP804(6),J806(2) | U818,CR809, RP803 |
| DIO3 | Data Bit 3 | U813(5) | 8C16 | U818(14),RP803(5), RP804(9),J806(3) | U818,CR810, RP803 |
| DIO4 | Data Bit 4 | U813(9) | 6CF2 | U818(1),RP803(4), RP804(10),J806(4) | U818,CR811, RP803 |
| DIO5 | Data Bit 5 | U813(11) | 3793 | U819(8),RP803(10), RP804(4),J806(13) | U819,CR812, RP803,RP804 |
| DIO6 | Data Bit 6 | U813(13) | 8C60 | U819(7),RP803(3), RP804(11),J806(14) | U819,CR813, RP803,RP804 |
| DIO7 | Data Bit 7 | U814(1) | A9C9 | U819(14),RP803(7), RP804(7),J806(15) | U819,CR814, RP803,RP804 |
| DIO8 | Data Bit 8 | U814(3) | 3P25 | U819(1),RP803(6), RP804(8),J806(16) | U819,CR815, RP803,RP804 |
| — | Data Bit 1 | U813(2) | HH8A | U807(2),RP802(4) | U813 |
| — | Data Bit 2 | U813(4) | 96U3 | U807(4),RP802(3) | U813 |
| — | Data Bit 3 | U813(6) | PH96 | U807(6),RP801(1) | U813 |
| — | Data Bit 4 | U813(8) | 0H42 | U807(8),RP802(2) | U813 |
| — | Data Bit 5 | U813(10) | 5113 | U807(11),RP802(8) | U813 |
| — | Data Bit 6 | U813(12) | PHP0 | U807(13),RP802(7) | U813 |
| — | Data Bit 7 | U814(2) | FU39 | U807(15),RP802(6) | U813 |
| — | Data Bit 8 | U814(4) | 58A5 | U807(17),RP802(5) | U813 |
| — | Data Bit 1 | U804(27) | HH8A | U806(18),U807(18), U808(18),U809(3), U810(14) | U807 |
| — | Data Bit 2 | U804(28) | 96U3 | U806(16),U807(16), U808(16),U809(4), U810(13) | U807 |
| — | Data Bit 3 | U804(29) | PH96 | U806(14),U807(14), U808(14),U809(7), U810(12) | U807 |
| — | Data Bit 4 | U804(30) | 0H42 | U806(12),U807(12), U808(12),U809(8), U810(11) | U807 |
| — | Data Bit 5 | U804(31) | 5113 | U806(9),U807(9), U808(9),U809(13), U811(14) | U807 |
| — | Data Bit 6 | U804(32) | PHP0 | U806(7),U807(7), U808(7),U809(14), U811(13) | U807 |
| — | Data Bit 7 | U804(33) | FU39 | U806(5),U807(5), U808(5),U809(17), U811(12) | U807 |
| — | Data Bit 8 | U804(34) | 58A5 | U806(3),U807(3), U808(3),U809(18), U811(11) | U807 |

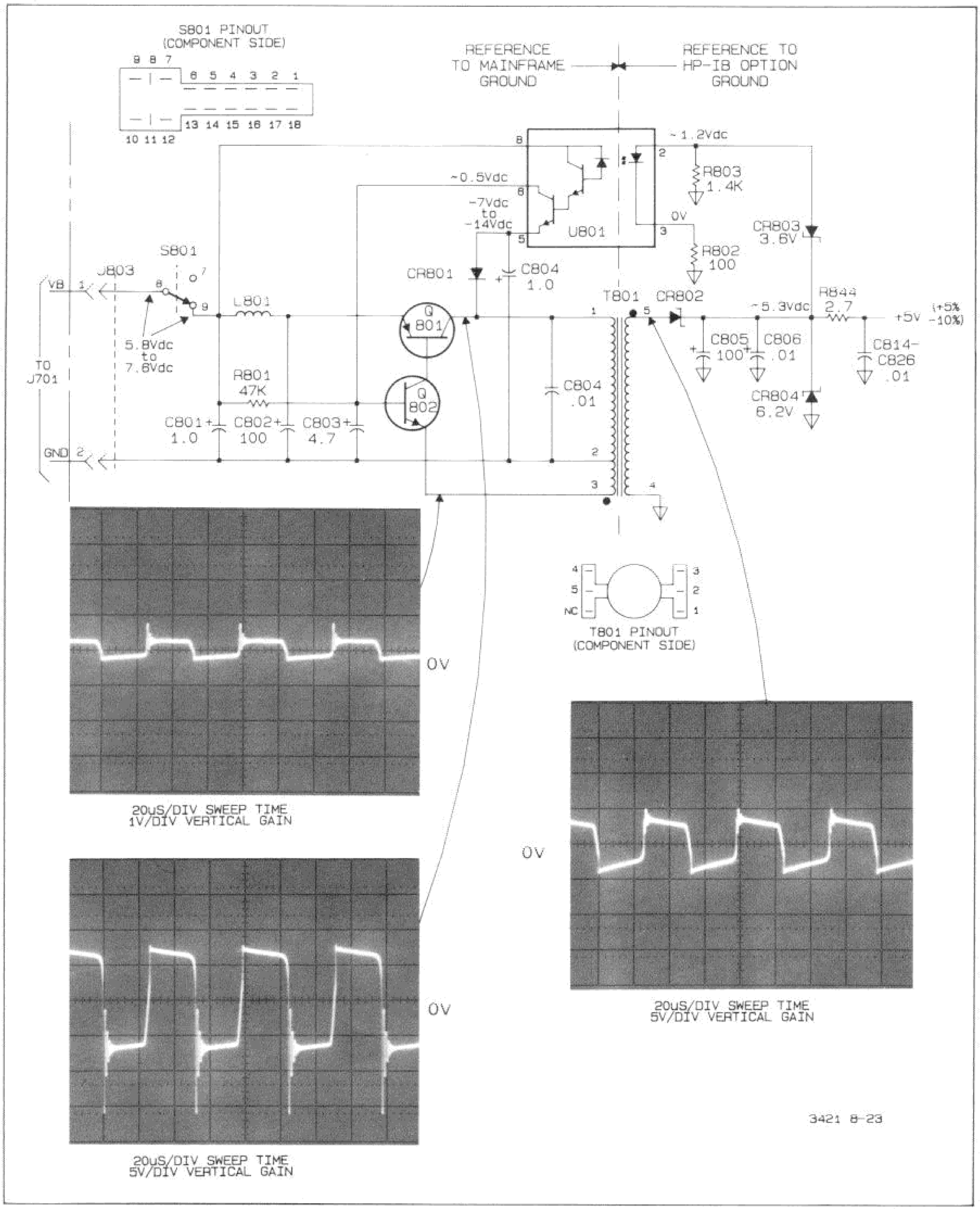
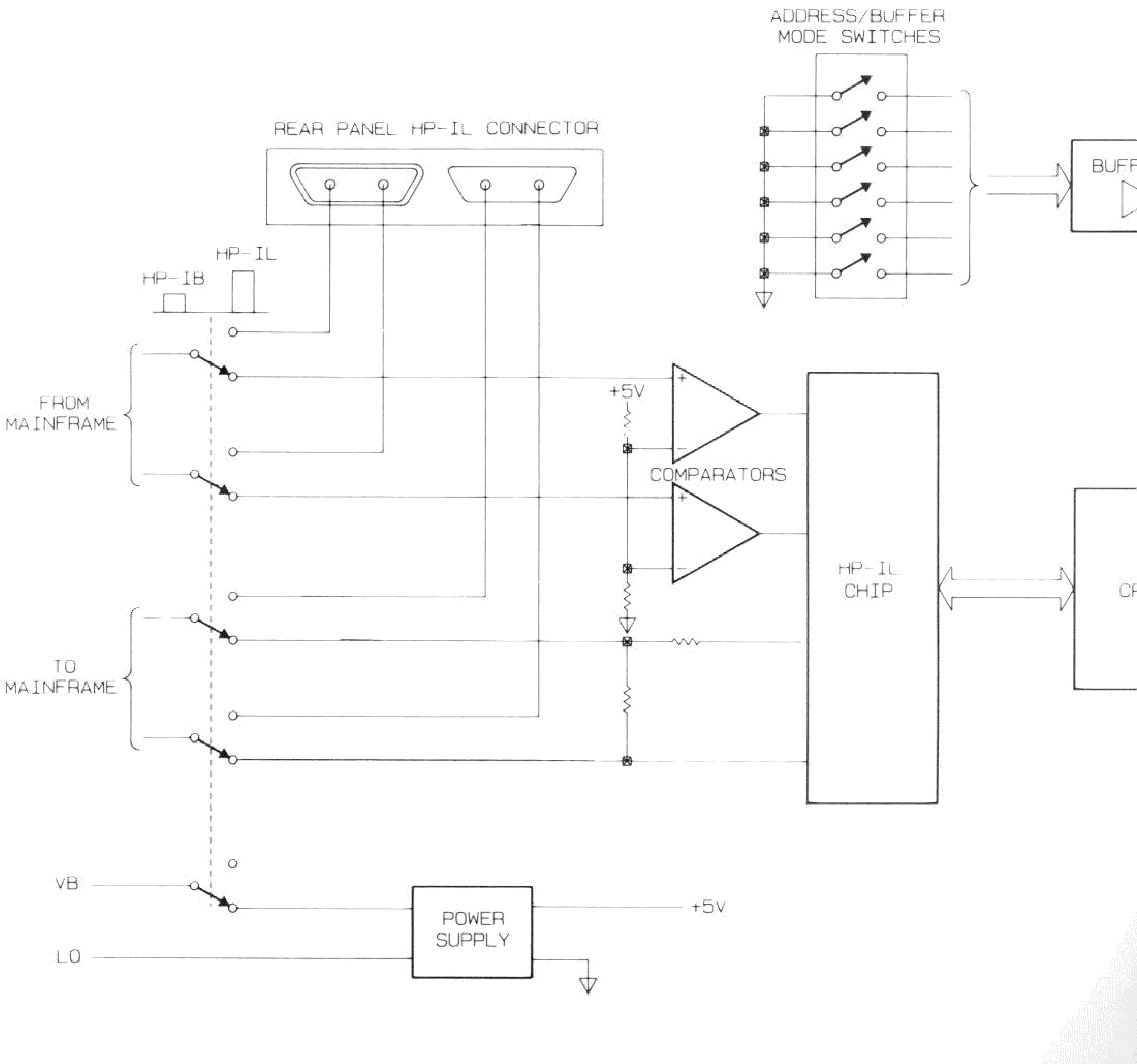



**Figure 4-8-23. +5V Power Supply Voltages and Waveforms**



ADDRESS/BUFFER MODE SWITCHES
REAR PANEL HP-IL CONNECTOR
BUFF
HP-IL
HP-IB
FROM MAINFRAME
+5V
COMPARATORS
HP-IL CHIP
CP
TO MAINFRAME
VB
LO
POWER SUPPLY
+5V

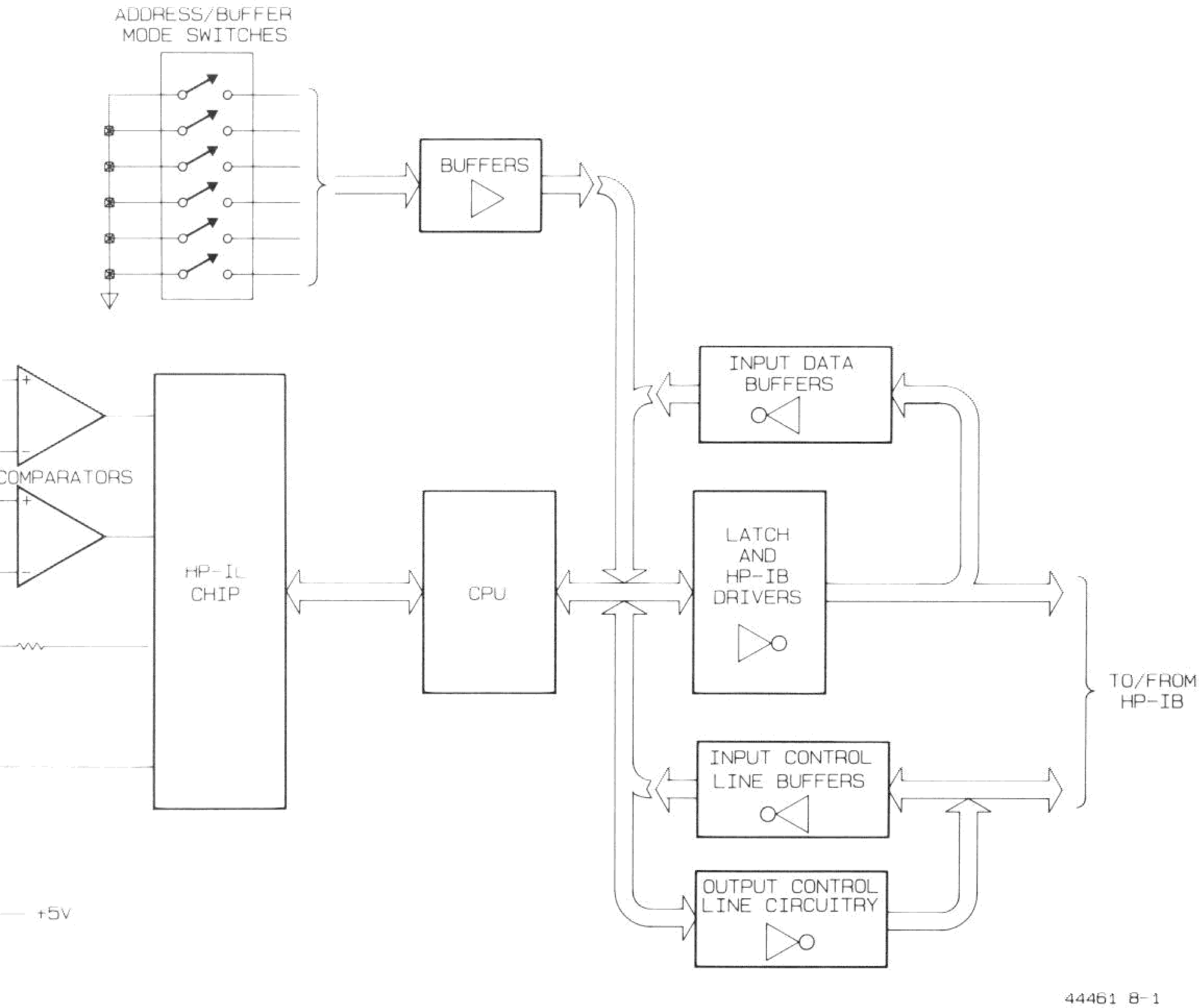
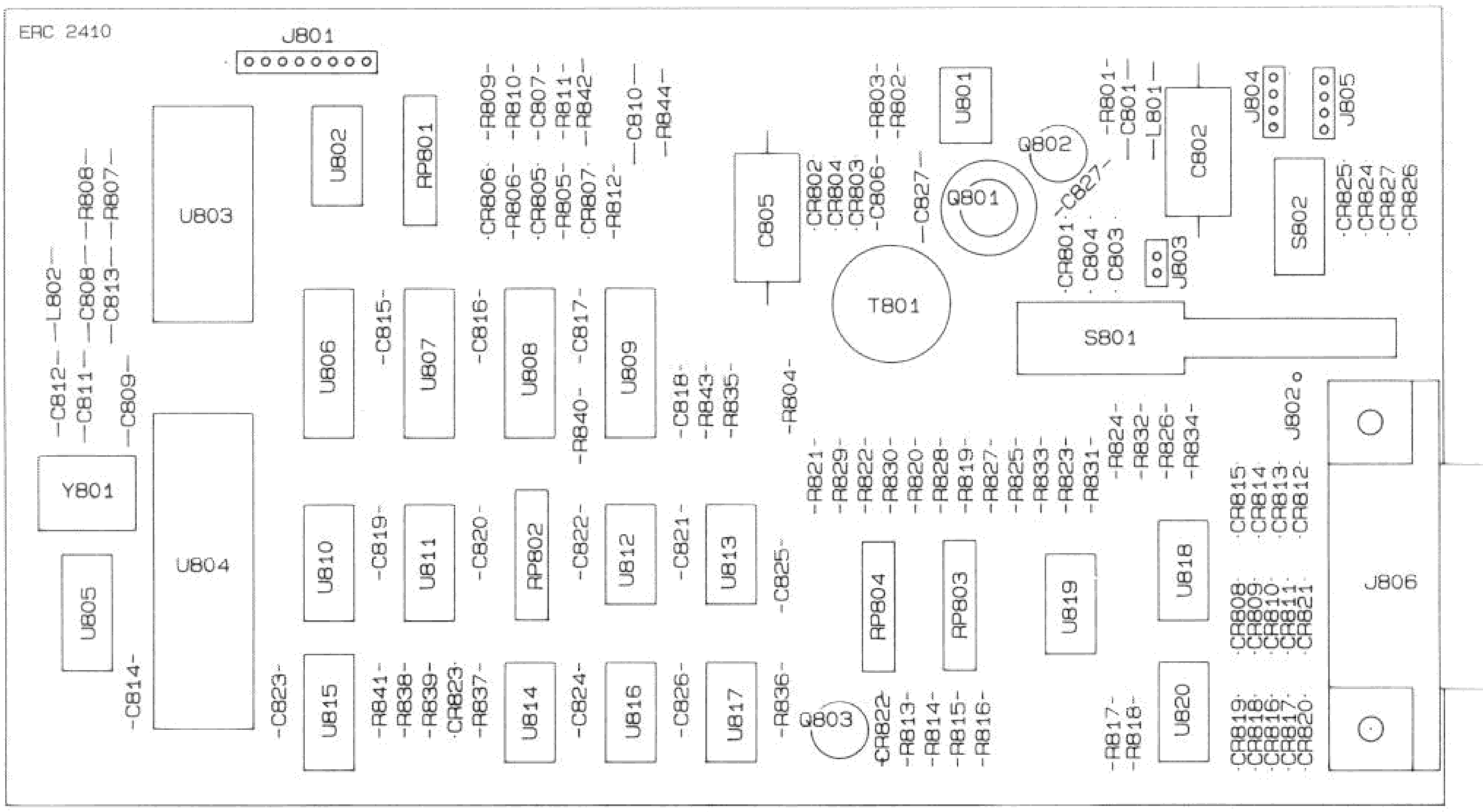
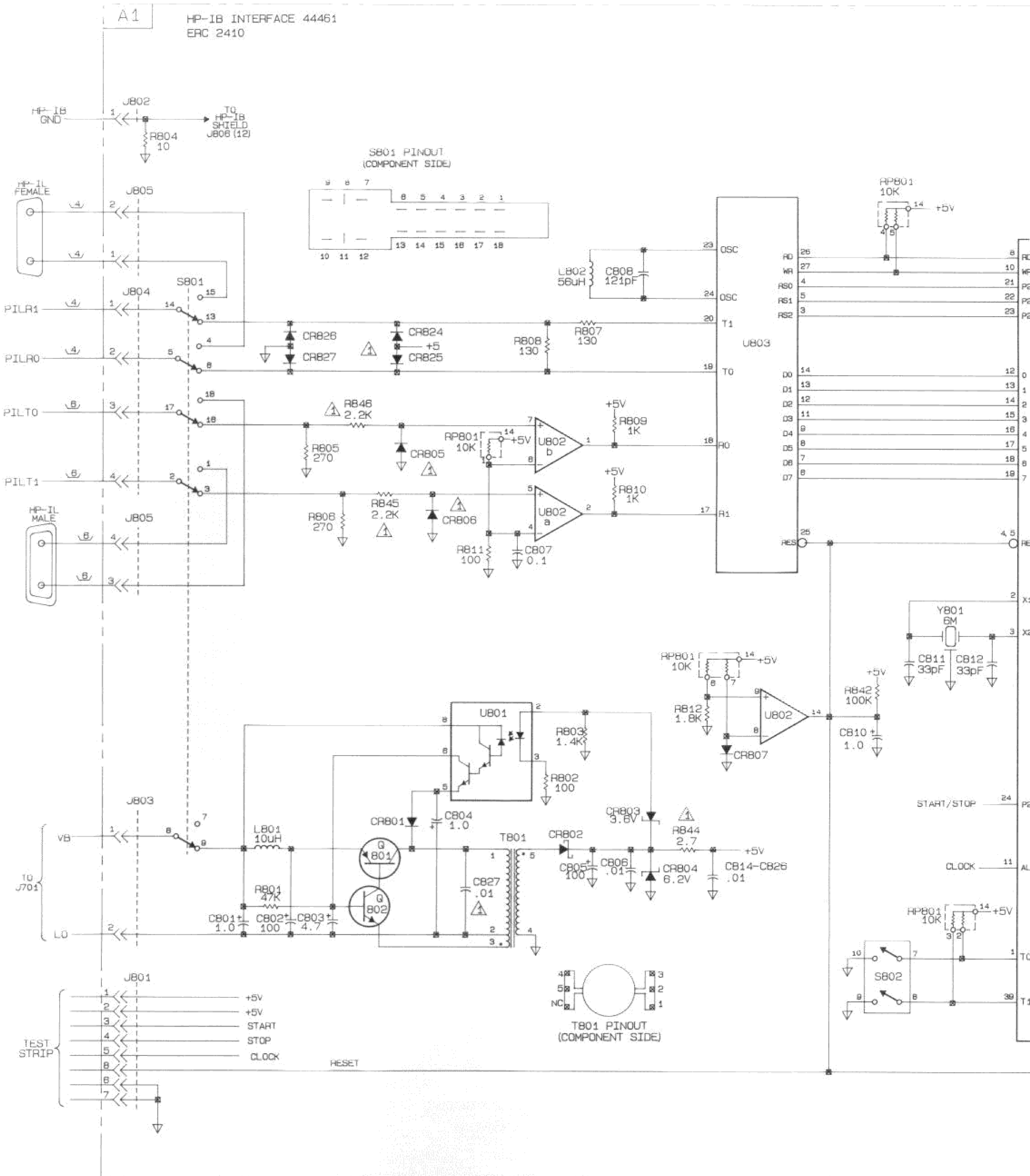



Figure 4-8-24. HP-IB Block Diagram

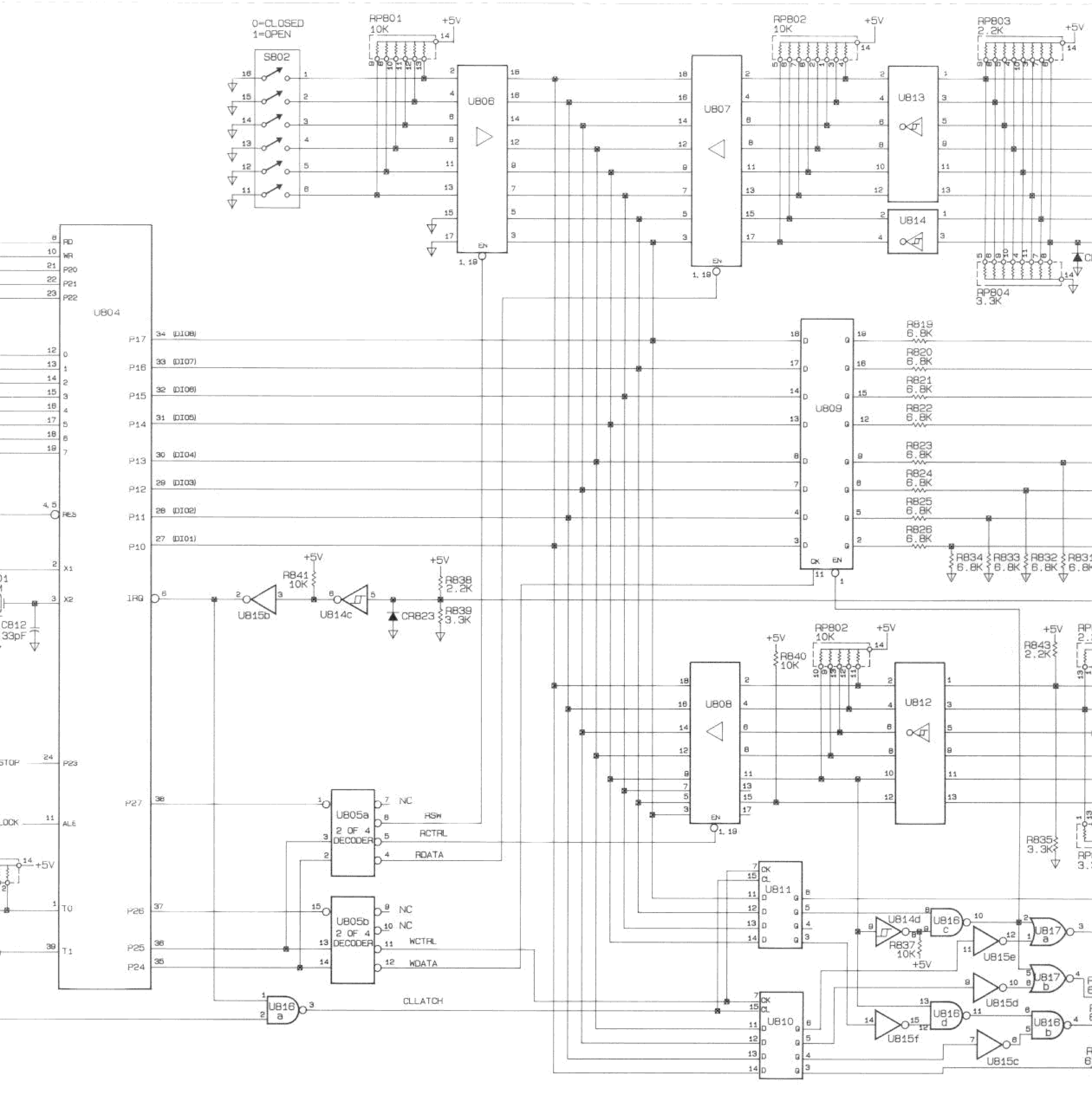



44461 0 1C

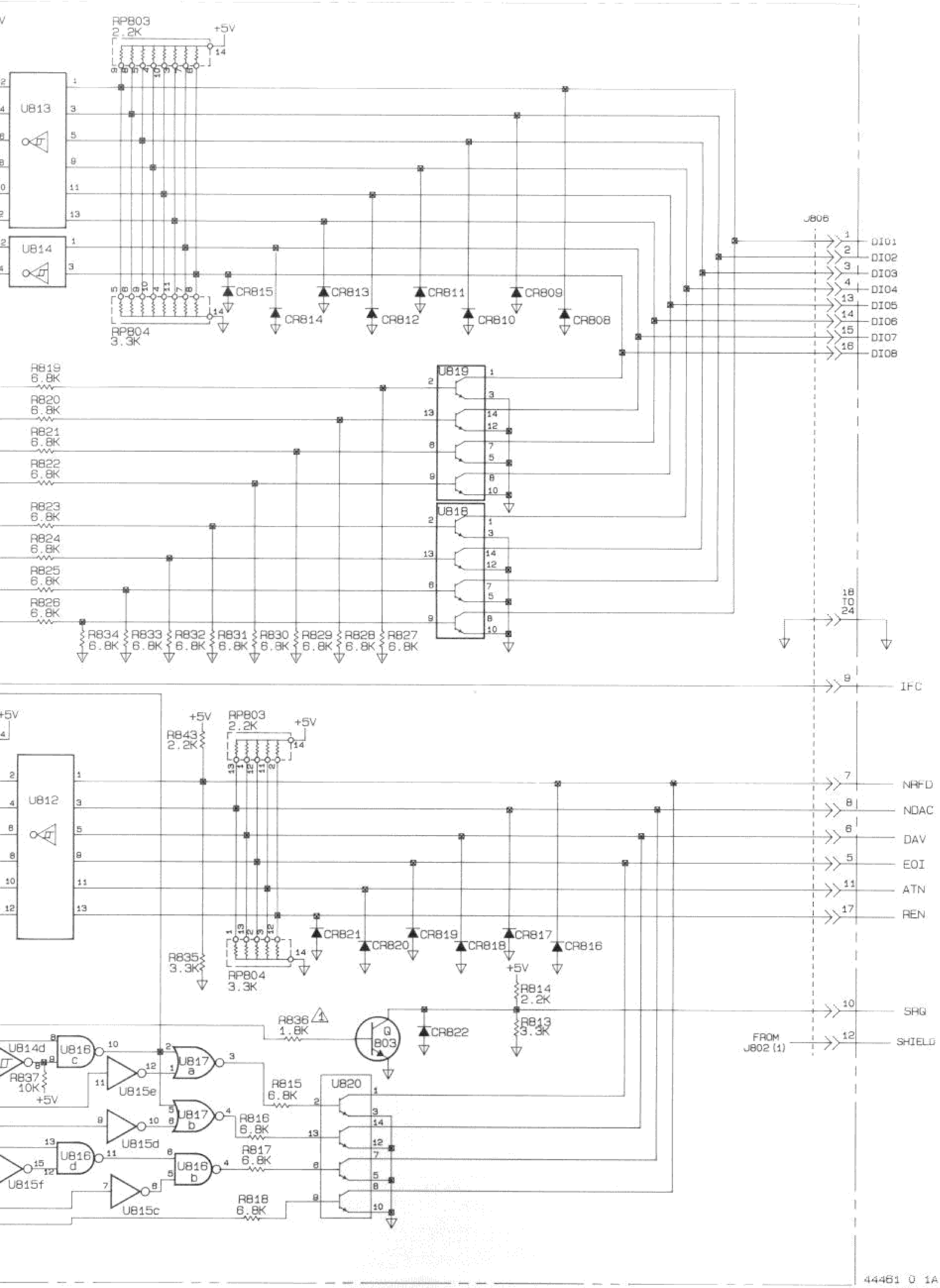
03421-66502

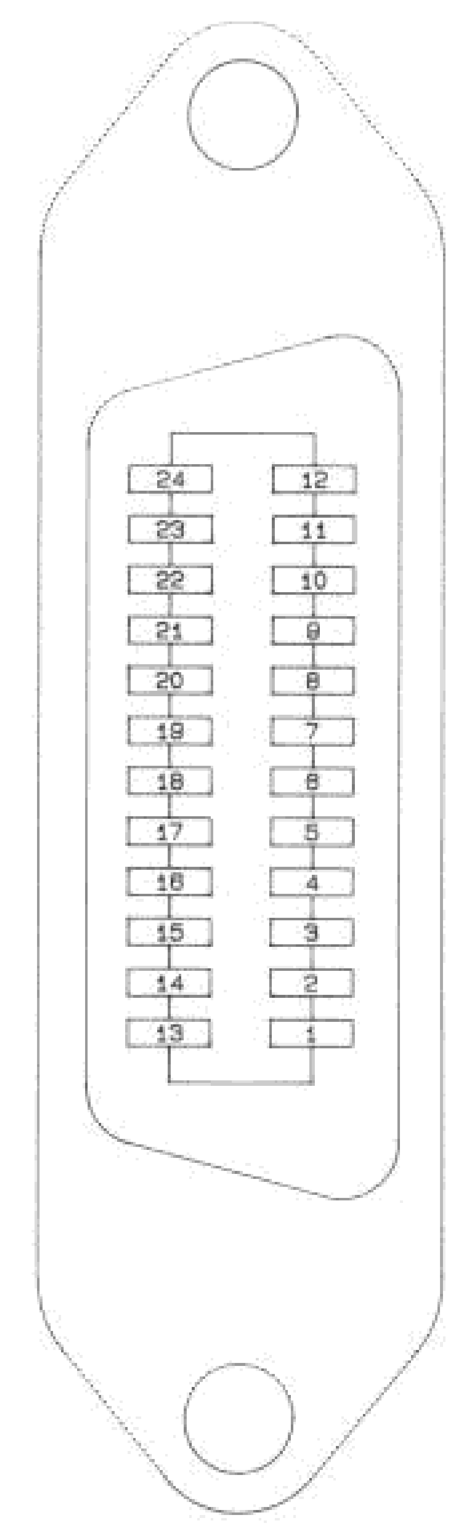



INDICATES A CHANGE FROM THE ORIGINAL DESIGN



0=CLOSED
1=OPEN
S802
RP801
10K
+5V
U806
RP802
10K
U807
RP803
2.2K
U813
U814
RP804
3.3K
U804
RD
WR
P20
P21
P22
P17
P16
P15
P14
P13
P12
P11
P10
(DI08)
(DI07)
(DI06)
(DI05)
(DI04)
(DI03)
(DI02)
(DI01)
RES
X1
X2
IRQ
U809
R819
6.8K
R820
6.8K
R821
6.8K
R822
6.8K
R823
6.8K
R824
6.8K
R825
6.8K
R826
6.8K
R834
6.8K
R833
6.8K
R832
6.8K
R841
10K
U815b
U814c
CR823
R838
2.2K
R839
3.3K
C812
33pF
R840
10K
U808
U812
R843
2.2K
R835
3.3K
STOP
P23
LOCK
ALE
P27
U805a
2 OF 4
DECODER
NC
RSW
RCTRL
RDATA
U811
P26
T0
U805b
2 OF 4
DECODER
NC
WCTRL
WDATA
U814d
U816
c
U817
a
R837
10K
U815e
P25
P24
T1
U815d
U817
b
U816
a
CLLATCH
U810
U815f
U816
d
U816
b
U815c



HP-IB CONNECTOR

Figure 4-8-25. HP-IB Schematic Diagram

# CHAPTER 5

# MODEL 3421A 12 Vdc POWER ADAPTER OPTION (OPTION 214)

# CHAPTER 5

# MODEL 3421A 12 Vdc POWER ADAPTER OPTION (OPTION 214)

**Engineering Revision Codes (ERCs)**

This chapter applies directly to power adapter with an engineering revision code of 2607. See Section VII of this chapter if your assembly has an ERC lower than 2607. If the ERC of your assembly is above 2607, updating information may be on a yellow *MANUAL CHANGES* supplement (located at the front of the manual). For Option 212 (older 12 Vdc Battery Option) refer to Section VII for backdating information.

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

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### CHAPTER 5



## LIST OF TABLES



## LIST OF ILLUSTRATIONS

## LIST OF ILLUSTRATIONS (Cont'd)

# SECTION I
# GENERAL INFORMATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 5-1-1. INTRODUCTION

5-1-2. This chapter is intended for qualified service trained personnel only. Other individuals refer to the "HP 3421A Operating, Programming, and Configuration Manual".

5-1-3. The 12 Vdc Power Adapter Option is intended to be installed only by the factory or HP Service Center. The programming information for the HP 3421A is unchanged when the option is installed. The information is found in the "HP 3421A Operating, Programming, and Configuration Manual". This chapter has eight sections that are assigned as follows:

**Section I - General Information**
This section describes the content of Chapter 5, has a brief description of the 12 Vdc Power Adapter Option, and lists its specifications.

**Section II - Installation**
This section explains how to connect the 12 Vdc Power Adapter Option to an external 12 Vdc source, and how to connect peripherals to the rear panel power supply ports.

**Section III - Operation**
This section normally contains operating information. No operating information for the battery option is given.

**Section IV - Performance Verification and Calibration**
This section contains the operational verification checks for the 12 Vdc Power Adapter Option.

**Section V - Adjustments**
This section normally has the adjustment procedures. Since the 12 Vdc Power Adapter Option has no adjustments, no procedures are in this section.

**Section VI - Replaceable Parts**
For ease in obtaining part numbers, all the replaceable parts for the 12 Vdc Power Adapter Option are in Chapter 1 (Mainframe Service Information), Section VI of the manual. Ordering information, and all chassis and mechanical parts are also included.

**Section VII - Manual Changes**
This section contains information to update this chapter for use with 12 Vdc Power Adapter Options that have ERC numbers different than shown on the title page of this chapter. It also adapts this chapter to assemblies that are different (eg, Option 212 assemblies) than what is described in this chapter.

**Section VIII - Service**
This section contains troubleshooting information, theory of operation, and the schematic.

## 5-1-4. DESCRIPTION

5-1-5. The 12 Vdc Power Adapter Option allows the HP 3421A Data Acquisition and Control Unit, an HP-71B Handheld Computer, an HP 9114B HP-IL Disc Drive, and an HP 2225B HP-IL ThinkJet Personal Printer to be operated from an external 12 V source, such as a standard 12 V automobile battery. This permits operation in remote locations where ac power is unavailable or where a battery backup is needed in case of an ac power failure.

5-1-6. A cable assembly is supplied with Option 214 that provides peripheral battery charging for the HP-71B computer, HP 9114B Disc Drive, and HP 2225B Printer only. The cable, when plugged into the HP 3421A rear panel, provides the charging voltage and current through various ports. This assumes that the battery option is connected to an external 12 Vdc source. The ports are inactive when the HP 3421A is connected to the ac line only.

## 5-1-7. PRINTED CIRCUIT BOARD IDENTIFICATION

5-1-8. The 12 Vdc Power Adapter Option Board is identified by the board number and the engineering revision code. These two numbers identify the electrical characteristics of the circuit board. The engineering revision code and board part number are listed on the schematic, component locator, and replaceable parts list.

5-1-9. In any service related correspondence, identify the printed circuit board by using the board number followed by the engineering revision code. For example:

03421-66515-2334

would identify a 12 Vdc Power Adapter Option circuit board having an engineering revision code of 2334.

## 5-1-10. BOARD PART NUMBER AND ERC NUMBERS

5-1-11. The HP part number of the printed circuit board is etched on the pc board. It is a ten digit number, separated by a hyphen into two groups of five digits. The first five digits identify the model or assembly number; the last five digits are unique to the assembly.

5-1-12. The ERC number is on a label which is the only one on the pc board that has a four digit number. This four digit code is in the form of YYWW, where YY is the last two digits of the year minus 60, and WW is the week. For example, an ERC of 2310 would identify a change that was made to the assembly in the tenth week of 1983. Refer to Chapter 1, Section I for more information on ERC numbers.

## 5-1-12. SPECIFICATIONS

5-1-13. The 12 Vdc Power Adapter Option specifications are listed in Table 5-1-1.

**Table 5-1-1. Specifications**

**NOTE**

*To maintain the specifications in this table, the external 12V source must have good load regulation, and the lead resistance specifications outlined in Figure 5-2-1 must be observed.*

Input Voltage: 11.5 Vdc to 15.3 Vdc*

Input Hysteresis: 11V (drop out)*
12 V (start up)*

Electronic Shutdown (Crowbar Threshold)
Voltage: 16.01 Vdc to 16.86 Vdc

Common Mode Rejection

Under normal operating conditions, the dc common mode rejection specification is the same as the mainframe specification without this option installed (140 dB). However, at 40°C, 65% relative humidity and above, the dc common mode rejection is degraded to 110 dB when the option is used with a grounded battery.

* The input voltage and input hysteresis specifications imply that the mainframe power supply will start up with a minimum external source voltage of 12 Vdc, and will continue to operate until the external source voltage drops to 11 Vdc (± .2 Vdc).

# SECTION II
# INSTALLATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 5-2-1. INTRODUCTION

5-2-2. This section explains how to connect the 12 Vdc Power Adapter Option to an external 12 Vdc source. It also explains how to connect the peripheral battery charging cables to an HP-71B Handheld Computer, an HP 9114B HP-IL Disc Drive, and an HP 2225B HP-IL ThinkJet Personal Printer.

## 5-2-3. EXTERNAL SOURCE VOLTAGE REQUIREMENTS AND PRECAUTIONS

5-2-4. The input voltage and hysteresis specifications must be considered collectively to insure for proper external voltage selection. Although the input voltage is specified as 11.5 Vdc to 15.3 Vdc, the mainframe voltage generated by the switching power supply on this option will probably not start unless the external voltage is 12 Vdc or greater. Also, the external voltage must have good load regulation. If the voltage drops below 11 Vdc (± .2 V), even momentarily, the switching power supply will turn off. When the switching power supply is started again, it will probably operate until the source voltage drops below 11 Vdc.

5-2-5. If the switching power supply shuts down due to a low external source voltage, the operation of the computer, disc drive, and printer power supply will not be affected. These devices will continue to operate providing their internal batteries have sufficient charge. Their supplies will discharge if no means is provided to maintain battery charge.

5-2-6. Always fuse the positive lead of the cable that connects to the external 12 Vdc source. The fuse must be rated at 2.5 A normal or fast blow and located no more than 6'' (~ 15 cm) from the 12 Vdc source. This will guard against a fire hazard and protect an external battery from being discharged or damaged should a short occur across the cable leads.

5-2-7. The 6' (~ 1.85 m) cable assembly that is provided with this option is to be used to connect the external 12 Vdc source voltage. If this cable is too short, another cable can be spliced onto it. When splicing cables, make sure to use the proper gauge wire (see Figure 5-2-1). Inadequate gauge wires can cause improper operation of this option. The total wire resistance must not exceed 0.2 Ω (i.e., the combined resistance of both wires in the cable assembly). Splices should be staggered, have good mechanical connections, and can be either soldered or crimped. Once the splices are made, insulate them with heat shrink tubing or electrical tape. It is not recommended that you disassemble the cable connector and resolder a new cable to it.

## 5-2-8. PERIPHERAL POWER SUPPLIES

5-2-9. A cable assembly is provided with Option 214 to supply power to the HP-71B Handheld Computer, HP 9114B HP-IL Disc Drive, and HP 2225B HP-IL ThinkJet Personal Printer. Do not attempt to power other peripherals from this cable assembly. The computer power cable is labeled "CONTROLLER ONLY". The other two cables provide the same output voltage and can be used for either the printer or disc drive.

5-2-10. The handheld computer, disc drive, and printer batteries can be charged from the cable assembly only when the battery option is connected to an appropriate 12 Vdc source. The peripheral battery charger supplies for these peripherals are inactive when the HP 3421A is powered from its internal battery or the ac line. The 12 Vdc Power Adapter Option, not the HP 3421A, generates the battery charging voltage for the external devices.

5-2-11. When using the printer and/or disc drive for extended periods, the time interval between readings must be maximized to prevent excessive discharge of these battery powered peripherals. Even with a maximum charge current supplied, these peripherals consume more power in their active states than an external charger is able to supply. This loss of power can be recovered during periods of HP-IL inactivity. This power recovery can be improved by programmatically placing the HP-IL device in a Low Power state between measurements and data sequences. Refer to the user documentation for your HP-IL computer for more information on sending the HP-IL message "Low Power Down".

## 5-2-12. PARTS NOT SUPPLIED BY HP

5-2-13. The parts that may be required to use this option are appropriate connectors for the end of the 6' cable that connects to the 12 Vdc source. Such connectors are not supplied by Hewlett-Packard. Also, if the 6' cable is not long enough for your requirements, it will be necessary to obtain an additional length of cable.

## 5-2-14. LENGTHENING THE 12 VDC SOURCE CABLE

5-2-15. This procedure explains how to lengthen the 6' cable assembly that was provided. If it is not necessary to lengthen the cable, disregard this procedure and proceed to paragraph 5-2-17. If you perform this procedure, it is very important to use the proper gauge wire and observe the correct lead polarity.

5-2-16. To lengthen the cable, perform the following steps.

a. Determine the cable length extension required. Then refer to Figure 5-2-1 to select the proper wire gauge. For example, if you need to splice on a 20' (6.1 m) cable, choose a wire gauge no less than 20 AWG.

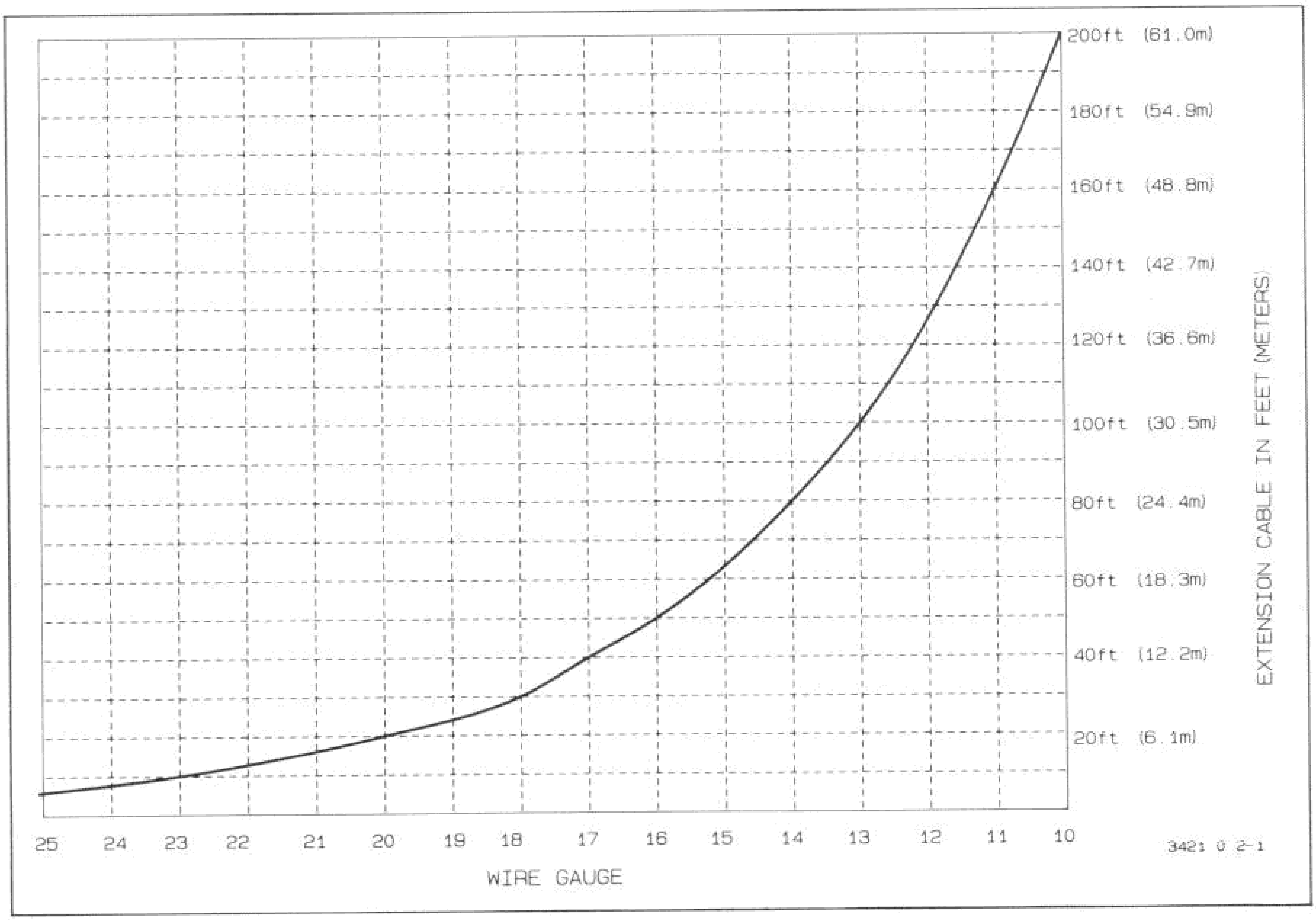



**Figure 5-2-1. Wire Gauge Vs. Cable Length**

b. Refer to Figure 5-2-2A and remove the fuse holder by cutting the wire approximately 3'' (~ 7 cm) from where the wires branch out of the cable. Do not cut the other cable wire.

c. Remove approximately 1 1/2'' (~ 3.5 cm) of insulation from both cable wires and from one end of the fuse holder wire as shown in Figure 5-2-2B.

d. If you are going to use heat shrink tubing for insulation, cut three pieces about 1 1/2'' long and place them over the two cable wires and the one end of the fuse holder where the insulation was removed. Slide the heat shrink tubing over the bare wire and onto the insulated portion of the wire. The heat shrink tubing can then be moved into place after the splices are made.

e. Prepare one end of the cable extension being added to match the staggered wire lengths of the cable that has just been cut. Make sure the positive lead in the cable extension is the long wire. See Figure 5-2-2C.

f. Observe polarity and splice the two cable assemblies together. The splices can be either soldered or crimped. For soldered splices, make sure they are mechanically secure before soldering. See Figure 5-2-2D.

g. Cover the splices with heat shrink tubing or electrical tape.

h. Prepare the end of the cable as shown in Figure 5-2-2E. Make sure the positive lead is the short wire.

i. If heat shrink tubing is to be used for insulation, cut a piece about 1 1/2'' (3.5 cm) long and place it over the end of the fuse holder where you previously removed the insulation.

j. Connect the fuse holder to the positive lead of the cable. The fuse holder may be connected using a soldered or crimped connection. A soldered connection should be mechanically secure before soldering. See Figure 5-2-2F.

**WARNING**

*Always fuse the positive lead of the cable that connects to the 12 Vdc source with a 2.5 A normal or fast blow fuse. The fuse should be placed no further than 6'' (15 cm) from the 12 Vdc source. This is especially important if the 12 Vdc source is a vehicle battery. If this is not done, equipment failure or shorted leads could deplete or damage the 12 Vdc source, or create a fire hazard.*

k. Cover the fuse holder splice with heat shrink tubing or electrical tape.

l. The final cable should resemble the one shown in Figure 5-2-2G.

### 5-2-17. CONNECTING THE EXTERNAL 12 VDC SOURCE

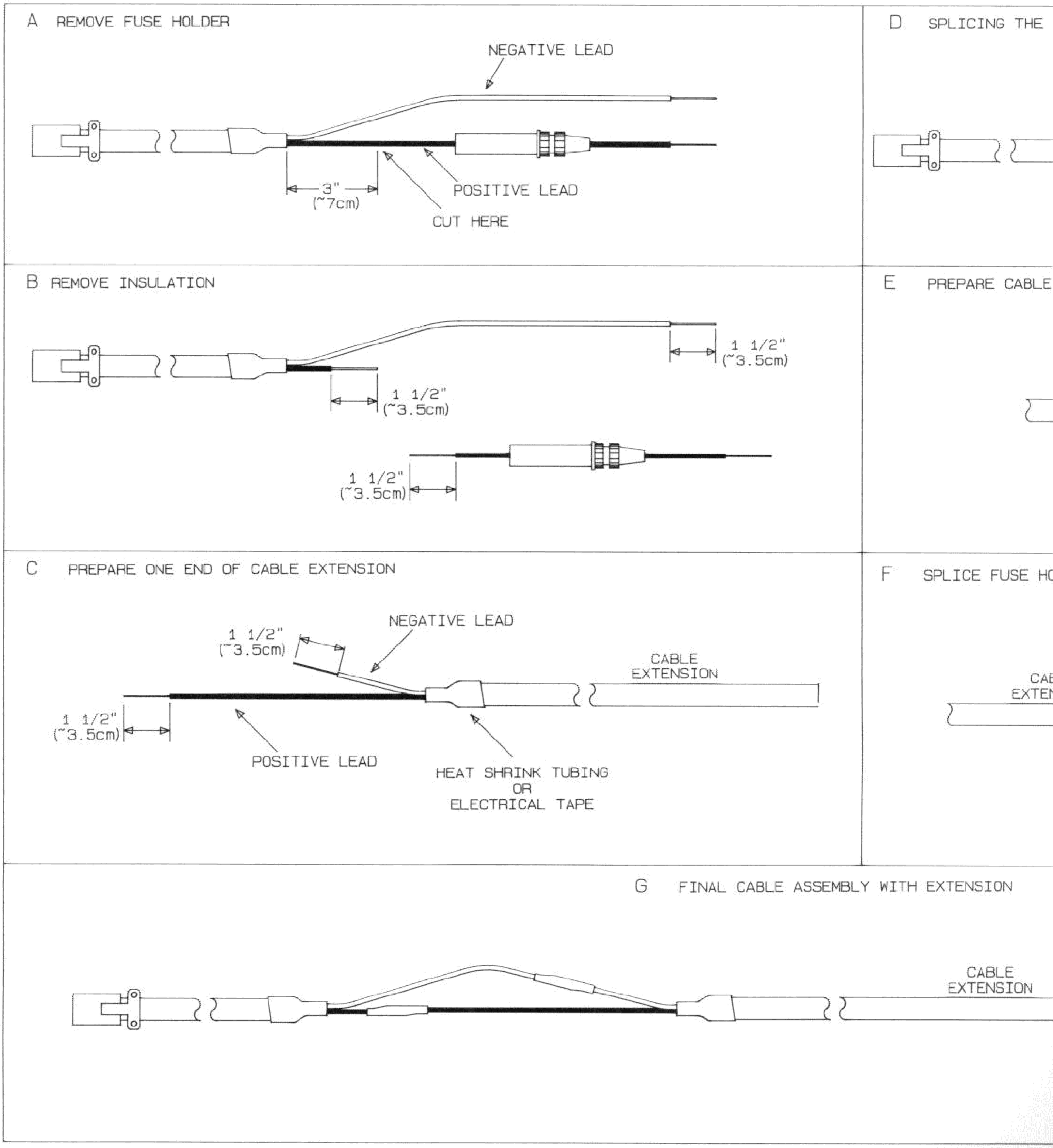
5-2-18. As specified, the external voltage must be between 11 Vdc ($\pm$ .2 V) and 12 Vdc for the switching power supply (used to power the HP 3421A) to operate. Also, the external voltage must be at least 11.5 Vdc to keep the batteries of the peripherals charged. However, the switching power supply does need 12 Vdc to start. A momentary interruption causing the supply voltage to go below 11 Vdc, but returns between 11 Vdc and 12 Vdc, can cause the switching supply to turn off. Prevent this from happening by using connectors that provide solid uninterruptable connections. Connectors can be used on the end of the cable assembly for the following procedure. Having connectors on the cable simplifies the connecting and disconnecting of the 12 Vdc source. For example, alligator clips on the ends of the cable could be used when connecting to a vehicle battery.

a. Connect the negative lead of the cable assembly to the negative ( − ) terminal of the 12 Vdc source.

b. Connect the positive lead of the cable assembly to the positive ( + ) terminal of the 12 Vdc source.

c. Plug the other end of the cable assembly into the rear panel of the HP 3421A. The connector is keyed so that it will only plug in one way.

d. You should now be able to power the HP 3421A from the external 12 Vdc source. Also, if the HP 3421A internal battery has a low charge, the external 12 Vdc source will serve as a charger as long as it is plugged into the HP 3421A rear panel.


A REMOVE FUSE HOLDER
NEGATIVE LEAD
3"
(~7cm)
POSITIVE LEAD
CUT HERE
B REMOVE INSULATION
1 1/2"
(~3.5cm)
1 1/2"
(~3.5cm)
1 1/2"
(~3.5cm)
C PREPARE ONE END OF CABLE EXTENSION
NEGATIVE LEAD
1 1/2"
(~3.5cm)
CABLE
EXTENSION
1 1/2"
(~3.5cm)
POSITIVE LEAD
HEAT SHRINK TUBING
OR
ELECTRICAL TAPE
D SPLICING THE
E PREPARE CABLE
F SPLICE FUSE HO
G FINAL CABLE ASSEMBLY WITH EXTENSION
CABLE
EXTENSION

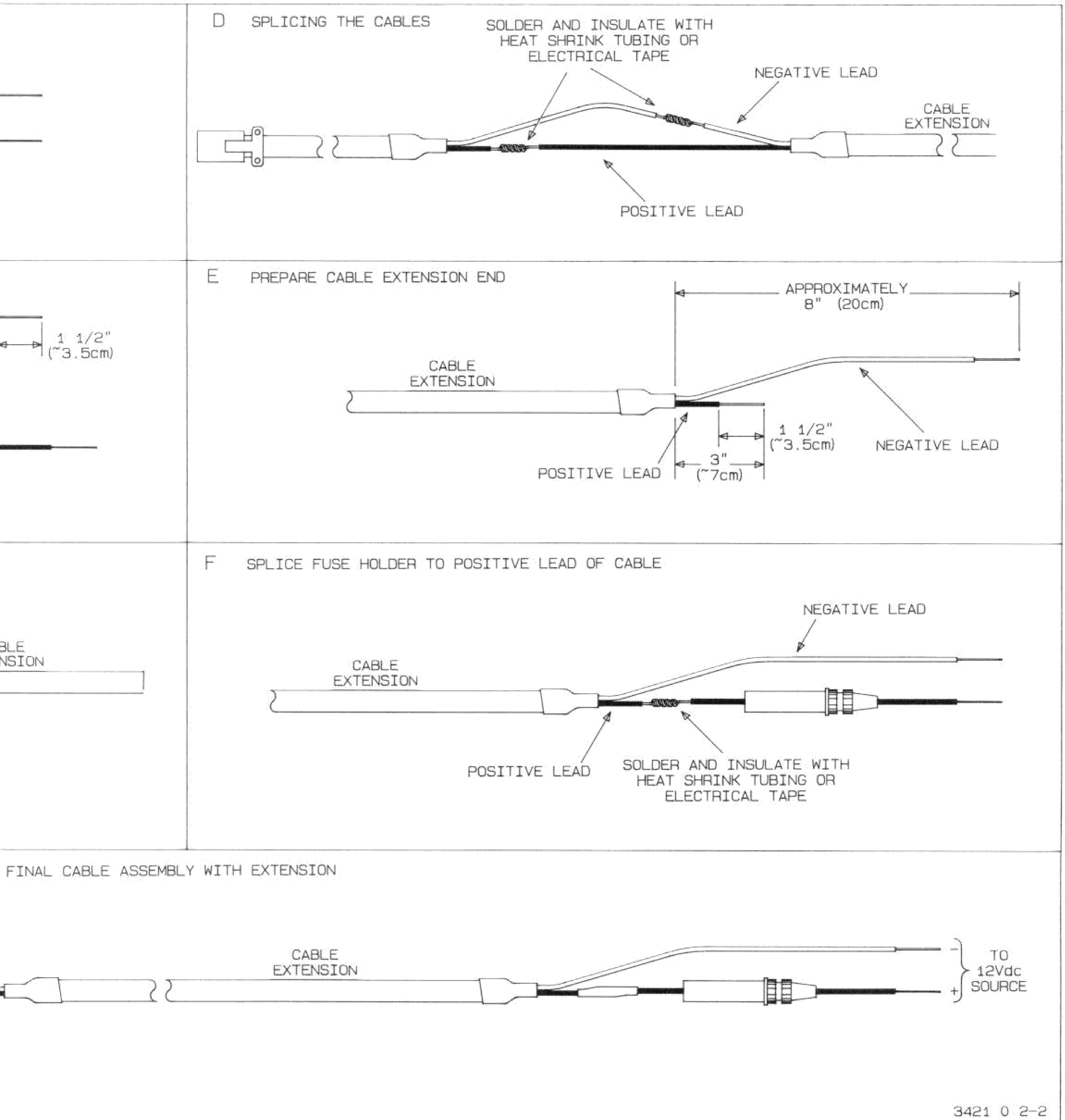



Figure 5-2-2. Lengthening the 12 Vdc Power Adapter Cable

## 5-2-19. CONNECTING THE PERIPHERAL POWER SUPPLIES

5-2-20. Refer to Figure 5-2-3 and perform the following procedure to connect the power supply cables to the peripherals.

a. Locate the peripheral power supply cable assembly and plug the end with the large connector into the HP 3421A rear panel. The connector is keyed and plugs into the rear panel only one way.

b. Identify the cable labeled "CONTROLLER ONLY" and plug it ONLY into the HP-71B. Do not attempt to use this cable for a different model controller.

c. The other two cables can be used to power an HP 2225B HP-IL ThinkJet Printer and an HP 9114B (not HP 9114A) HP-IL Disc Drive. Either cable can go to either device, but do not attempt to use the cables to power any other peripheral device, including the HP 9114A Disc Drive.

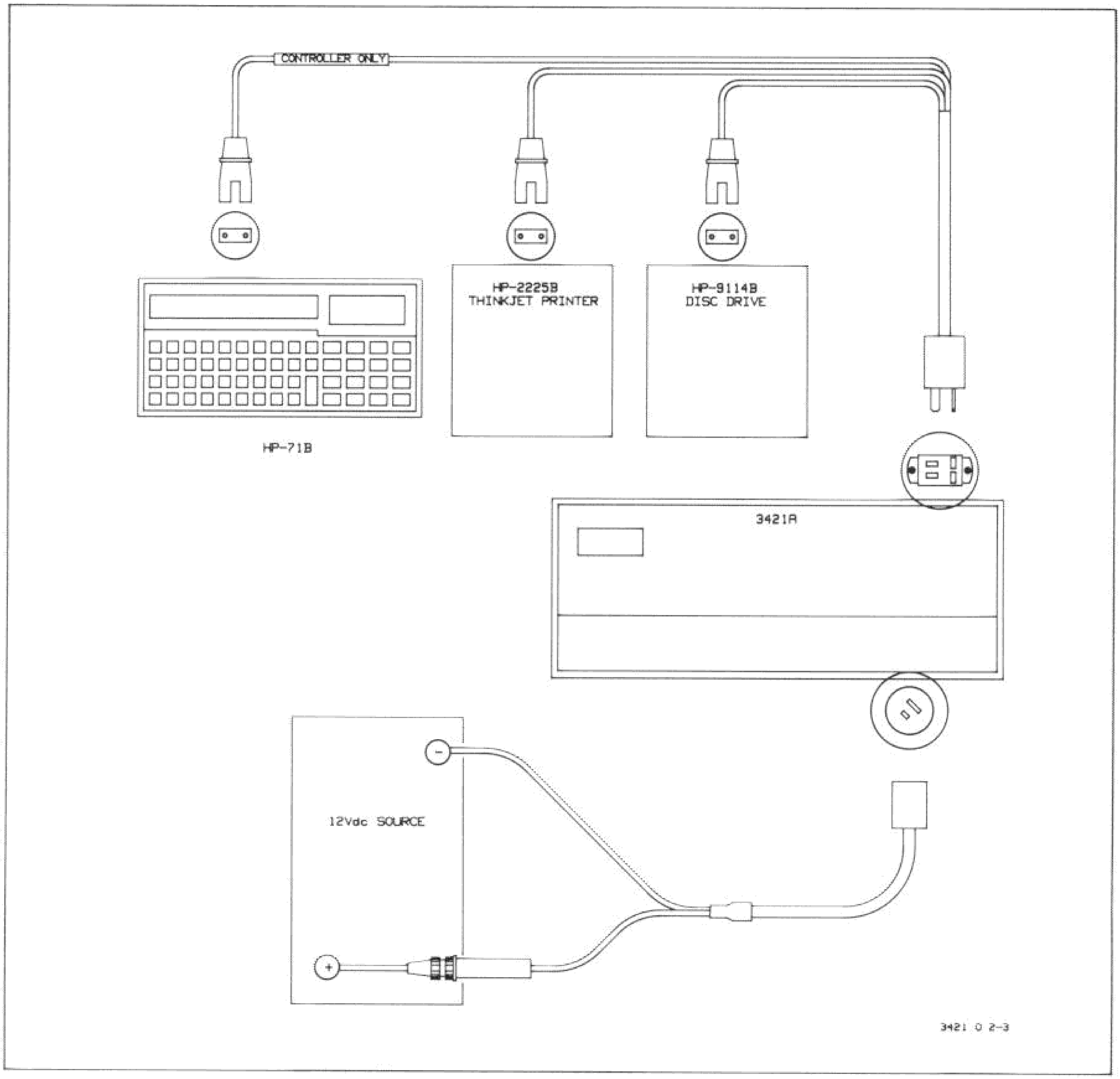



**Figure 5-2-3. Power Supply Connections**

## 5-2-21. HP-IL CONNECTIONS

5-2-22. The HP-IL I/O connections are illustrated in Figure 5-2-4.

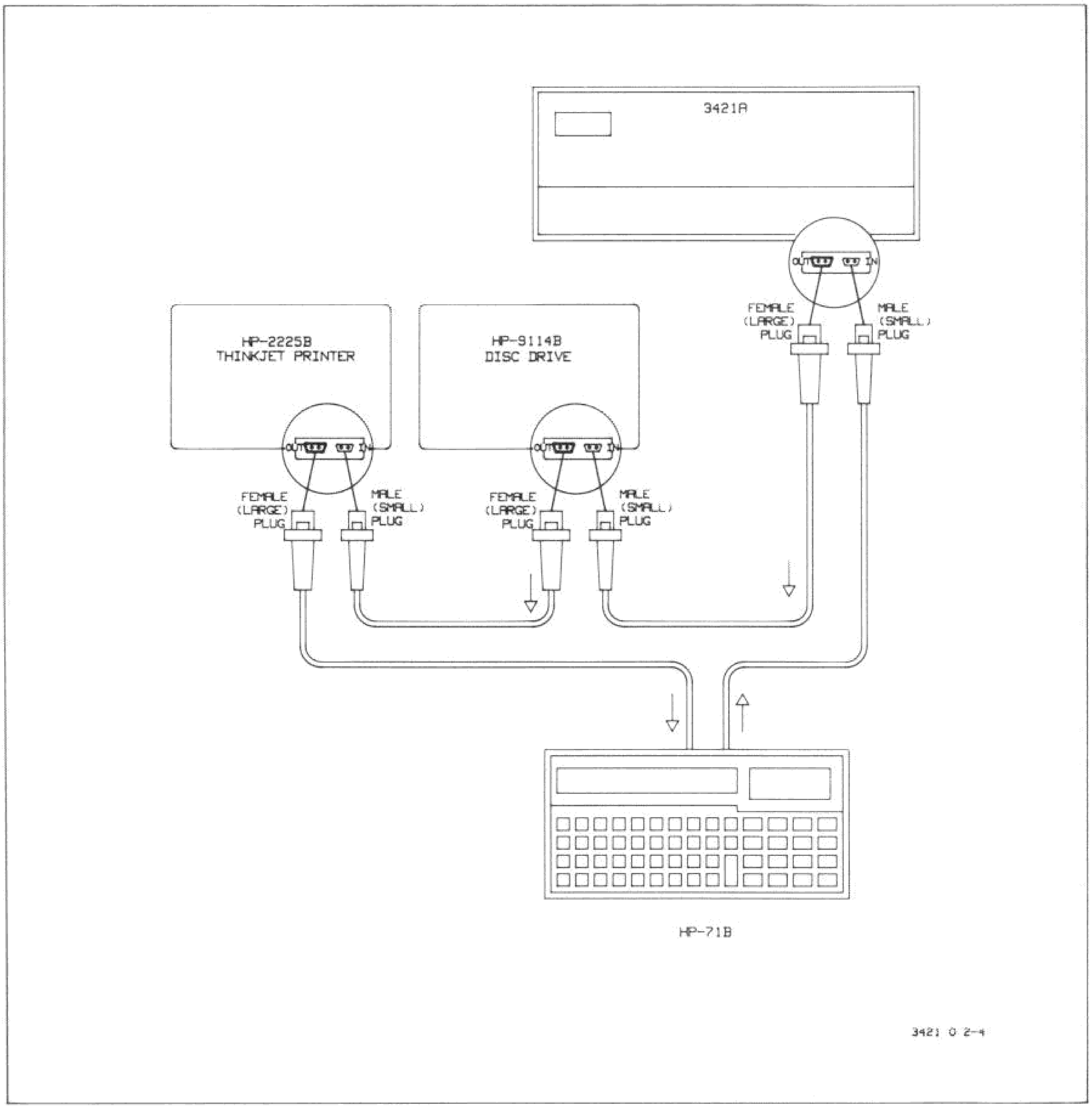



**Figure 5-2-4. HP-IL I/O Connections**

# SECTION III
# OPERATION

5-3.1. This section normally contains operating instructions. However, operation of the HP 3421A is unchanged with the 12 Vdc Power Adapter Option installed. Refer to the "HP 3421A Operating, Programming, and Configuration Manual" for the Model 3421A operating instructions.

# SECTION IV
# OPERATION VERIFICATION

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 5-4-1. INTRODUCTION

5-4-2. This section contains an operational verification procedure for the 12 Vdc Power Adapter Option. The procedure allows you to check the various power supply voltages that are generated by this option.

## 5-4-3. RECOMMENDED EQUIPMENT

5-4-4. A digital voltmeter (like the HP 3456, 3468, or 3478) is recommended to perform these tests.

## 5-4-5. OPERATION TEST PROCEDURE

5-4-6. Use the following procedure to check the operation of the 12 Vdc Power Adapter Option. To do this, the HP 3421A's top cover needs to be removed. This procedure is included in the following procedure.

a. Make sure the HP 3421A is turned off and the ac power cord is disconnected from the instrument. Also make sure all external sources of power have been removed from the option terminal blocks.

b. Turn the instrument upside down. This is preferably done on top of a protective mat to reduce the possibility of scratching or marring the instrument case. Use a static safe mat to prevent any buildup of static electricity. Refer to Figure 5-4-1 and loosen the six screws on the instrument bottom.

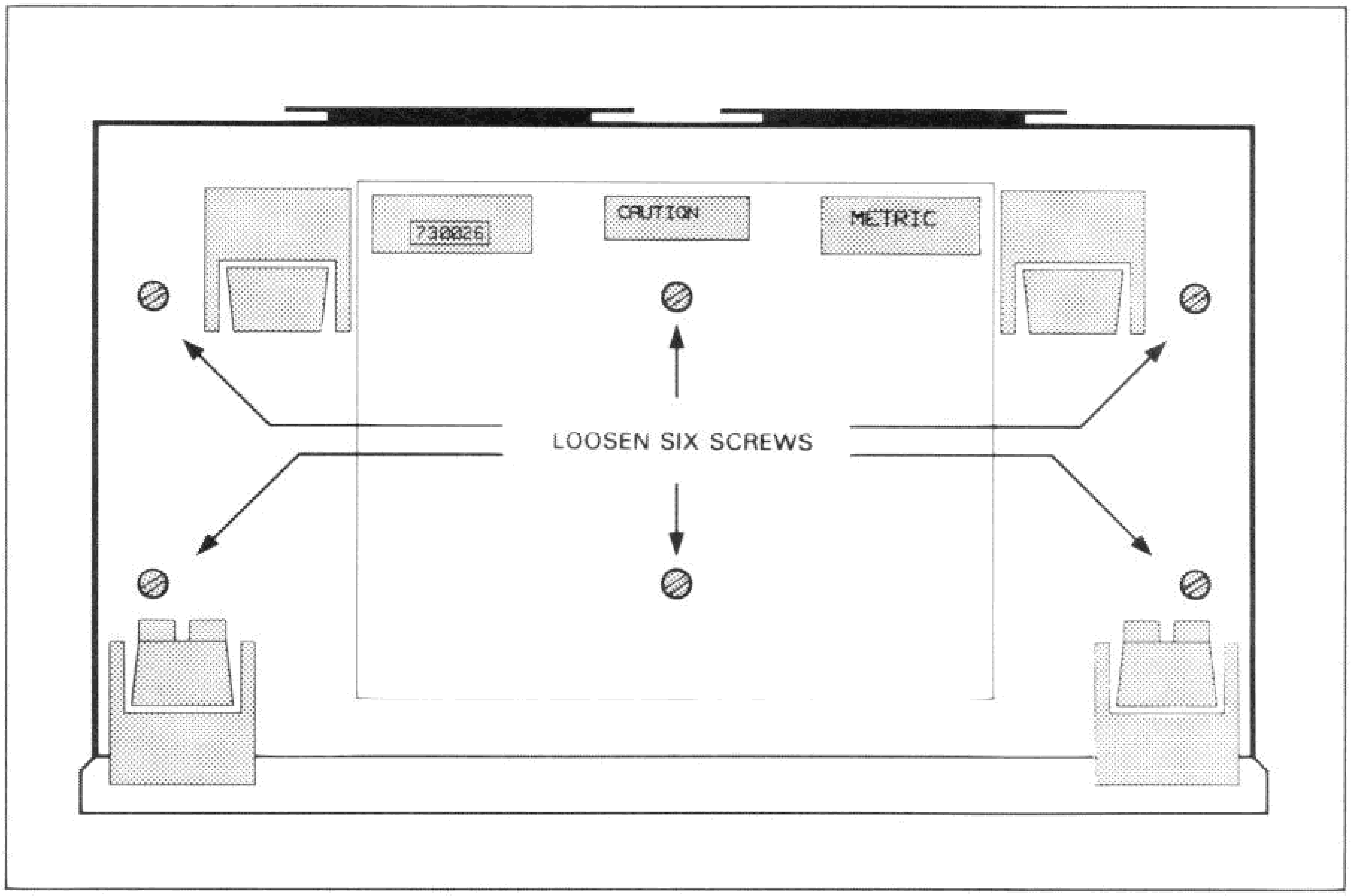



**Figure 5-4-1. Loosen Bottom Screws**

c. Hold the top cover in place and turn the instrument upright.

d. Then remove the top cover.

e. For all installed options that have external connections, remove the strain relief, grey "WARNING" safety cover, and terminal block edge connectors as follows:

1. Remove the two screws holding the black strain relief bar.

2. Loosen the two captive screws that hold the grey "WARNING" safety cover.

3. Loosen the two screws holding the terminal block to the option circuit board and then remove the terminal block.

f. Connect the 12 Vdc source to the rear panel connector per the instructions given in Section II of this manual. Make sure the instrument is disconnected from the ac line.

g. Connect the negative lead of your digital voltmeter to the HP 3421A instrument ground. The transformer shield or motherboard GND test point are convenient ground connections.

h. Locate C700, the 1100 $\mu$F motherboard capacitor. This is the large capacitor behind the HP 3421A front panel display.

i. Use the positive lead of the voltmeter and probe the positive (+) side of C700. The voltage should read between 10 Vdc and 14 Vdc. If the voltage is correct, the mainframe power supply is OK. If the voltage is incorrect, check F801 (the 2.5 A option fuse accessible from the rear panel), F700 (the 2 A fuse located on the motherboard toward the right rear of the instrument), and the fuse in the positive lead at the 12 V source before troubleshooting.

j. Locate the peripheral power supply cable assembly (P/N 03421-61603) and plug it into the rear panel connector.

k. Locate the power cable for the HP-71B. It is labeled "CONTROLLER ONLY". Measure for 10 Vdc (± .5 V) across the two pins in the end of the cable connector. The voltage can be either positive or negative, dependent on voltmeter connection. If the voltage is correct, the controller power supply is good. If incorrect, do the following:

1. Unplug the power supply cable assembly from the rear panel connector.

2. Refer to Figure 5-4-2 and check for 10 Vdc (± .5 V) at the rear panel connector, as indicated in the figure. If the voltage is correct but incorrect or missing in step k, the cable assembly is defective.

3. If the voltage at the rear panel connector is incorrect, make sure all posts on the rear panel connector have wires connected to them. Make sure the wires are connected to the 12 Vdc Power Adapter Option (see Section VIII, paragraph 5-8-73 to verify proper wiring). It may be necessary to remove the four screws securing the option and lifting out the option to verify proper connection. If the wires appear to be connected properly, go the Section VIII in this chapter for troubleshooting.

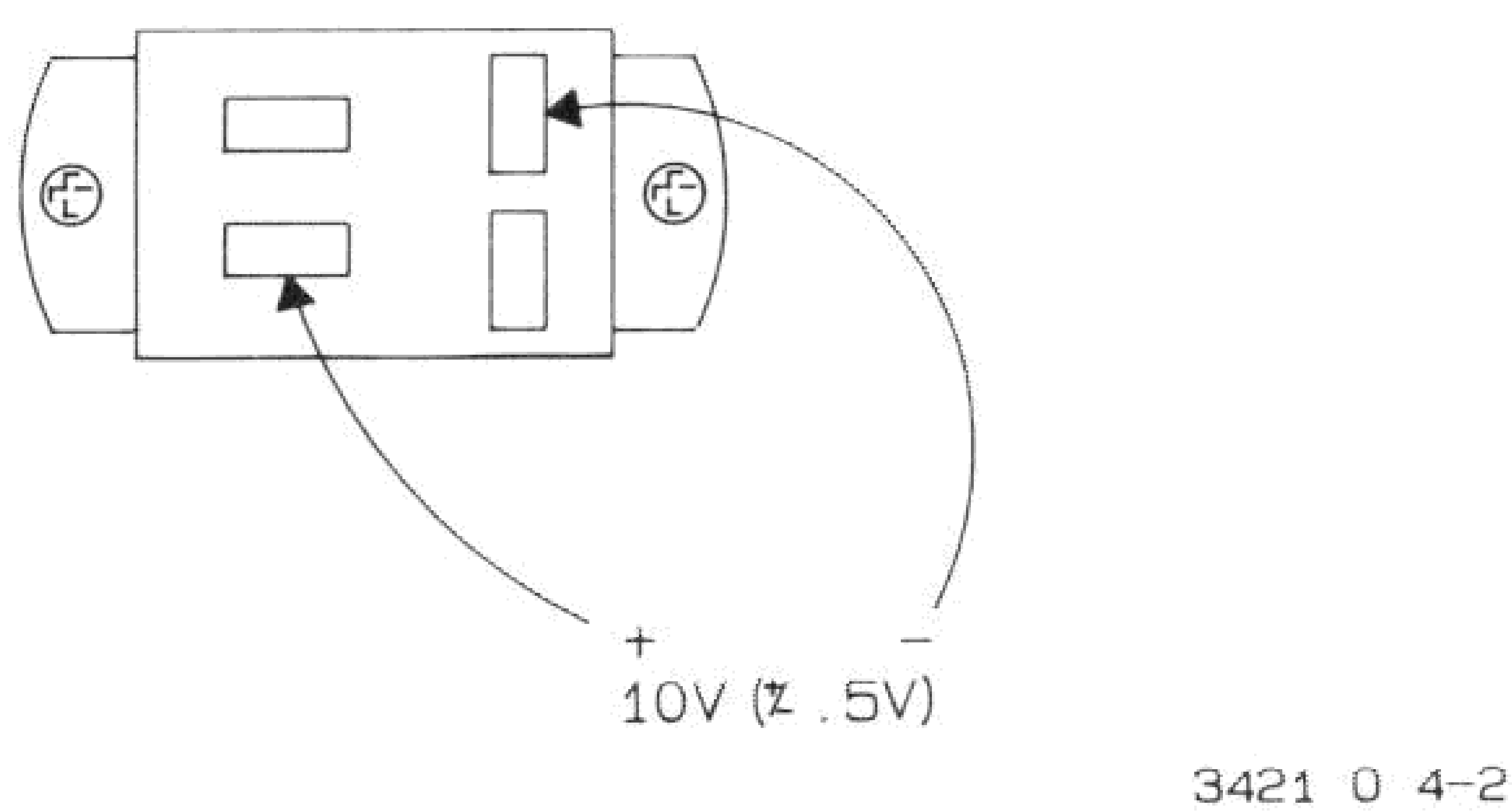



**Figure 5-4-2. HP-71B Power Supply Connections**

l. Locate the power cables for the disc drive and printer. These are the cables without labels. Measure the voltage across the two pins in the end of each cable connector for 10.2 Vdc (± .3 V). These voltages can be either positive or negative, dependent on voltmeter connection. If these voltages are correct, the disc drive and printer power supplies are good. If either voltage is incorrect, do the following:

1. Unplug the power supply cable assembly from the rear panel connector.

2. Refer to Figure 5-4-3 and check for 10.75 Vdc ( ± .25 V) at the rear panel connector, as indicated in the figure. If both voltages are correct but incorrect or missing in step 1, the cable assembly is defective.

3. If either voltage at the rear panel connector is still incorrect, make sure all posts on the rear panel connector have wires connected to them. Make sure the wires are connected to the 12 Vdc Power Adapter Option (see Section VIII, paragraph 5-8-73 to verify proper wiring). It may be necessary to remove the four screws securing the option and lifting out the option to verify proper connection. If the wires appear to be connected properly, go the Section VIII in this chapter for troubleshooting.

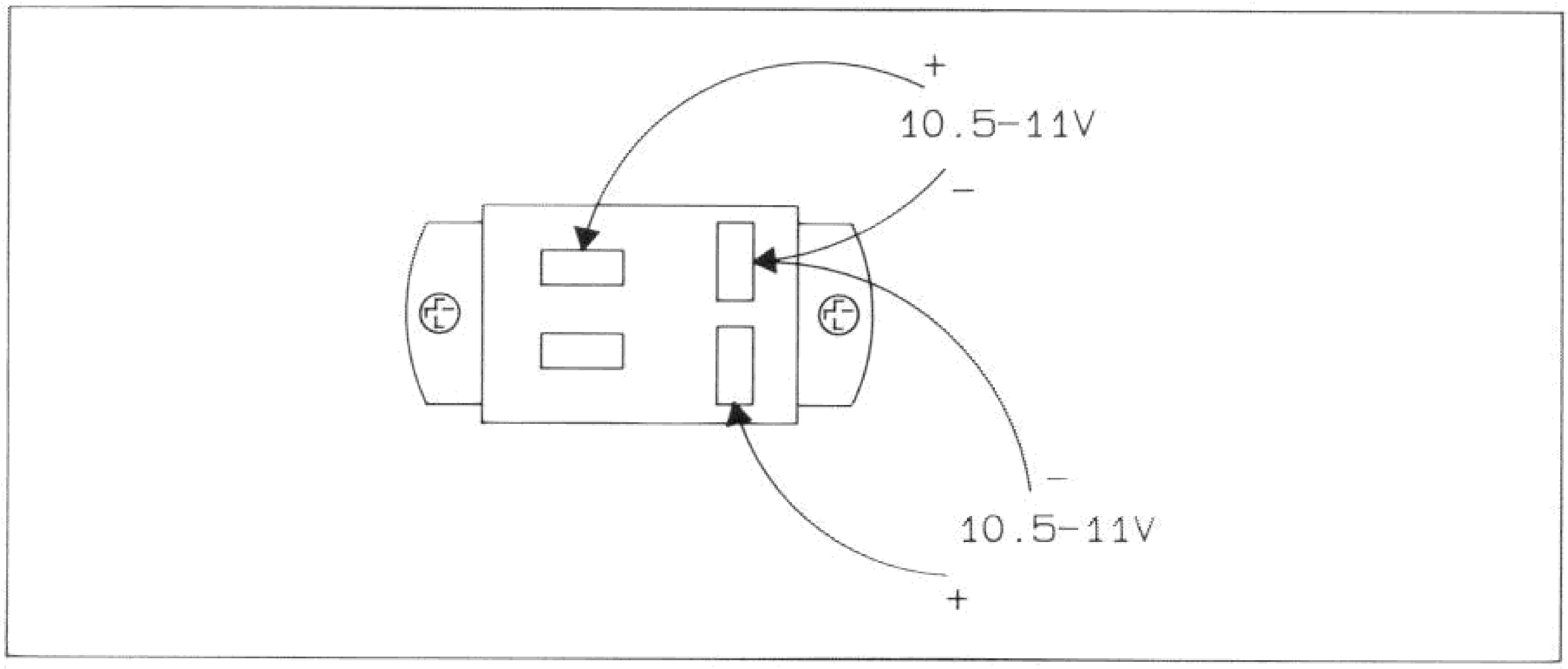



**Figure 5-4-3. Disc Drive and Printer Power Supply Connections**

m. If all voltages check good on the power supply cable, the 12 Vdc Power Adapter Option can be assumed to be operational.

n. To reassemble the case, do the following:

1. Refer to Figure 5-4-4 and make sure the plastic spacers are in place.

2. Align the top cover and lower it into place. Be sure the guiding grooves are properly engaging the front and rear panels. If the grooves are properly engaged but the top cover will not lower into place, one or more of the six plastic spacers is probably out of alignment. To correct this, move the top cover back and forth (left and right) until the spacers align properly.

3. Once the top cover is in place, hold the two case halves together and turn the instrument upside down. Tighten the six bottom screws.

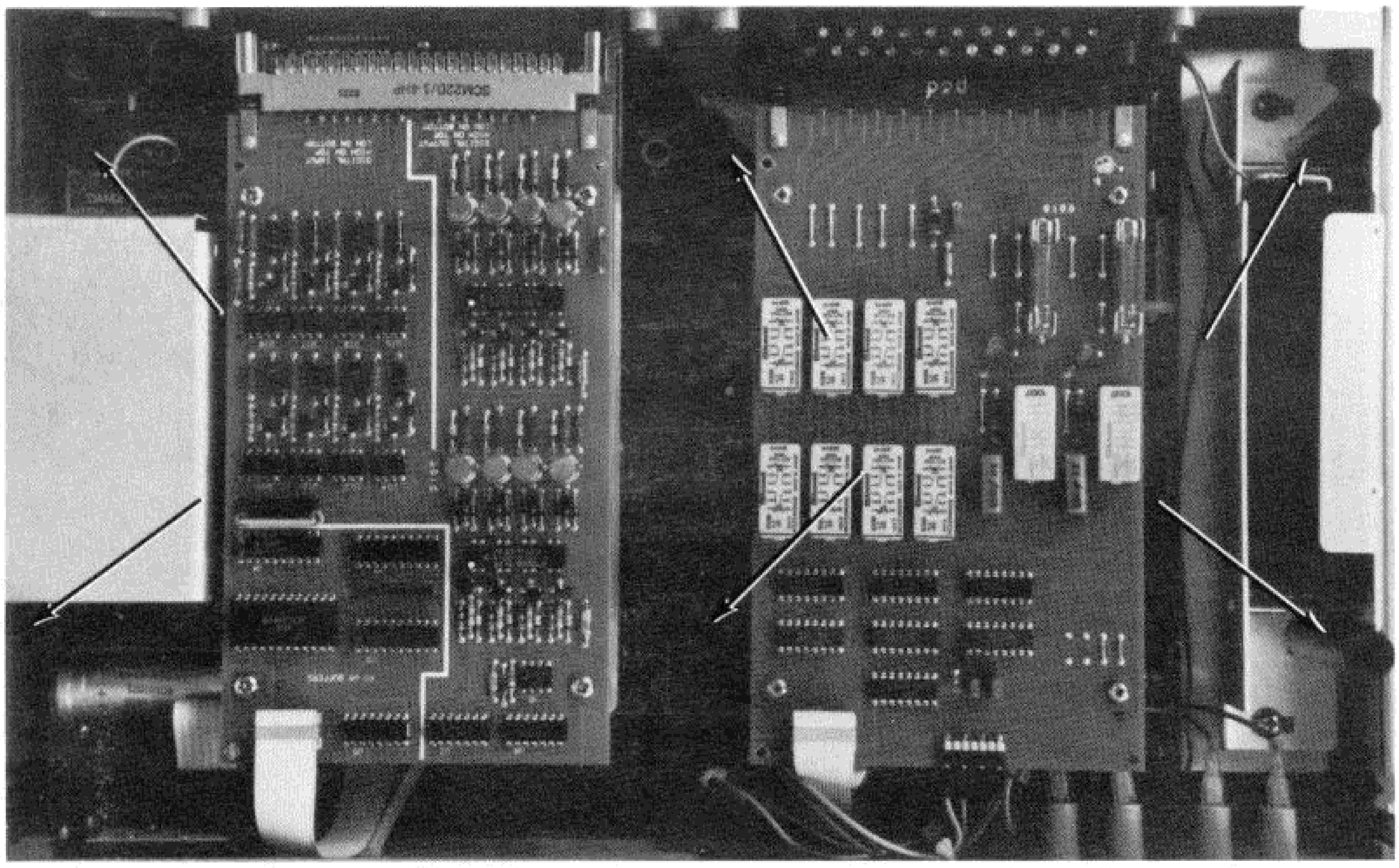


Figure 5-4-4. Plastic Spacer Placement

# SECTION V
# ADJUSTMENTS

5-5-1. This section normally contains adjustment procedures. Since the 12 Vdc Power Adapter Option has no adjustments, no adjustment information in this section.

# SECTION VI
# REPLACEABLE PARTS

5-6-1. This section normally contains information for ordering replaceable parts. However, the replaceable parts for the 12 Vdc Power Adapter Option are included in Chapter 1 (Mainframe Service Information), Section VI of the manual.

# SECTION VII
# MANUAL CHANGES

## 5-7-1. INTRODUCTION

5-7-2. This section has information to adapt this manual to older 12 V Battery Options purchased as Option 212. This section also applies to battery options or 12 VDC Power Adapter Option that have no ERC (Engineering Revision Codes) number or a number lower than shown on the title page.

### 5-7-3. Engineering Revision Code (ERC)

5-7-4. The engineering revision code (ERC) is changed whenever a change is made to an assembly. The change could be a printed circuit board revision, a component value change, added or deleted component, a component part number change, or a revised test and assembly procedure. The ERC label is the only one on the printed circuit board that has a four digit number. ERCs were implemented on this instrument with the introduction of the 03421-66511 motherboard. The first ERC was 2334. Refer to Chapter 1 (Mainframe Service Information), Section I for more information on ERC numbers.

## 5-7-5. CHAPTER CHANGES

5-7-6. Most changes in this section apply to the schematics and component locators in Section VIII, and to the parts list (Table 1-6-7) in Chapter 1, Section VI of the manual. If there is only a minor change, like a component value change or a minor circuit change, modify the appropriate schematic and Table 1-6-7 presently in the manual. If a major change to a schematic is made, refer to the schematic and component locator in this section of the chapter, instead of Section VIII.

5-7-7. If the ERC number of your option is different than listed on the title page, do the changes in this section. If the ERC number is larger than listed on the title page, refer to the supplied *MANUAL CHANGES* supplement for updating information. Also, if a *MANUAL CHANGES* supplement is supplied, make all indicated ERRATA changes to correct any errors in this chapter.

### CHANGE 1

#### Description

This changes the peripheral power supply circuitry to the one used in Option 212. The circuitry is replaced by two regulators instead of the circuitry presently used in Option 214.

**CAUTION**

*The Option 212 circuitry is designed to operate with the HP-41C/CV or HP-75C Handheld Computer, HP-82161A Cassette Drive, and HP-82162A Thermal Printer. Do not use the option with other than the recommended peripheral devices or damage to the devices may result.*

Change the peripheral power supply circuitry to the one shown in Figure 5-7-1.

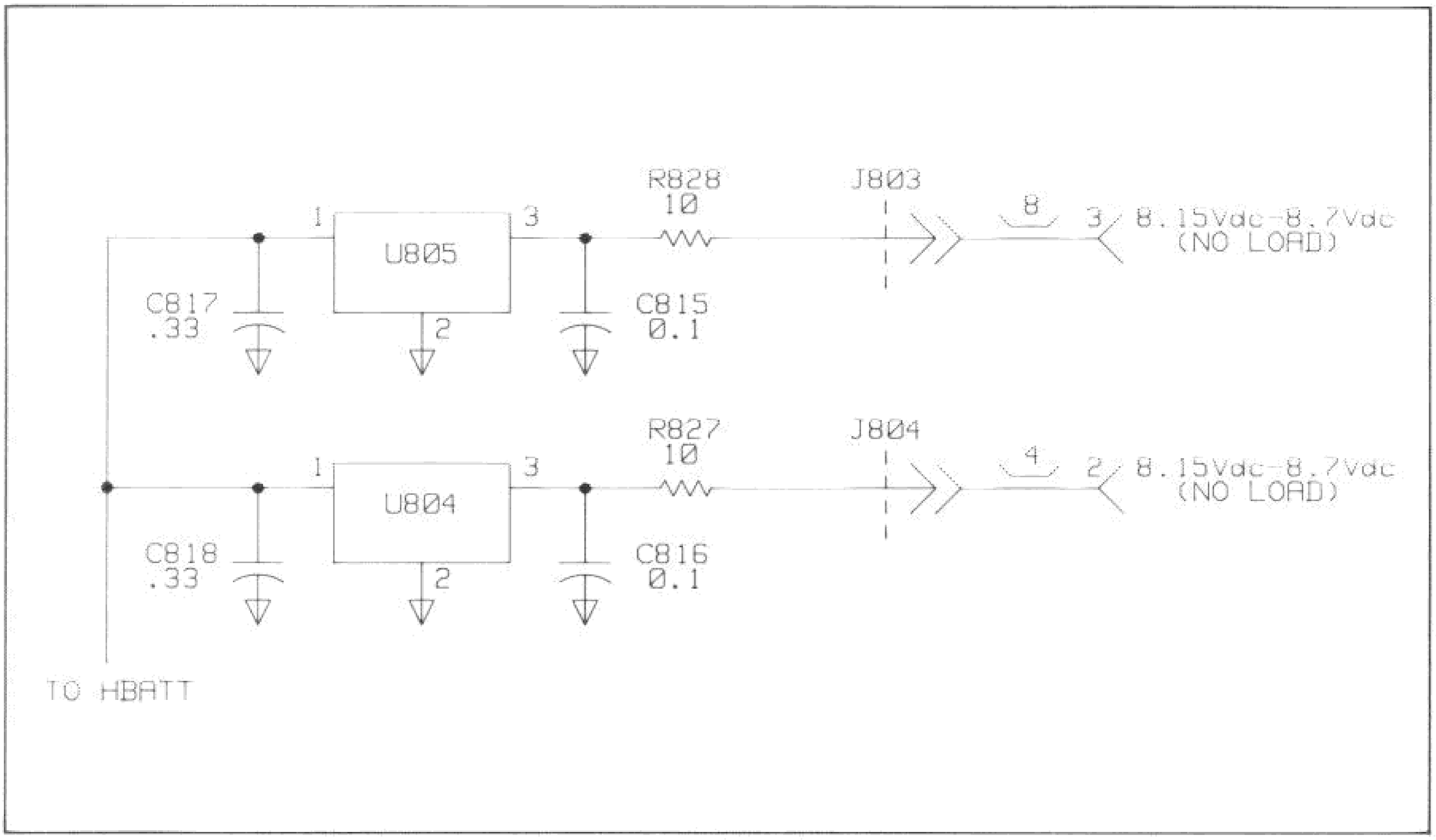



**Figure 5-7-1. Peripheral Power Supply Changes on the Schematic**

### Component Locator Changes

Use the component locator in Figure 5-7-2 instead of the locator in Figure 5-8-12.

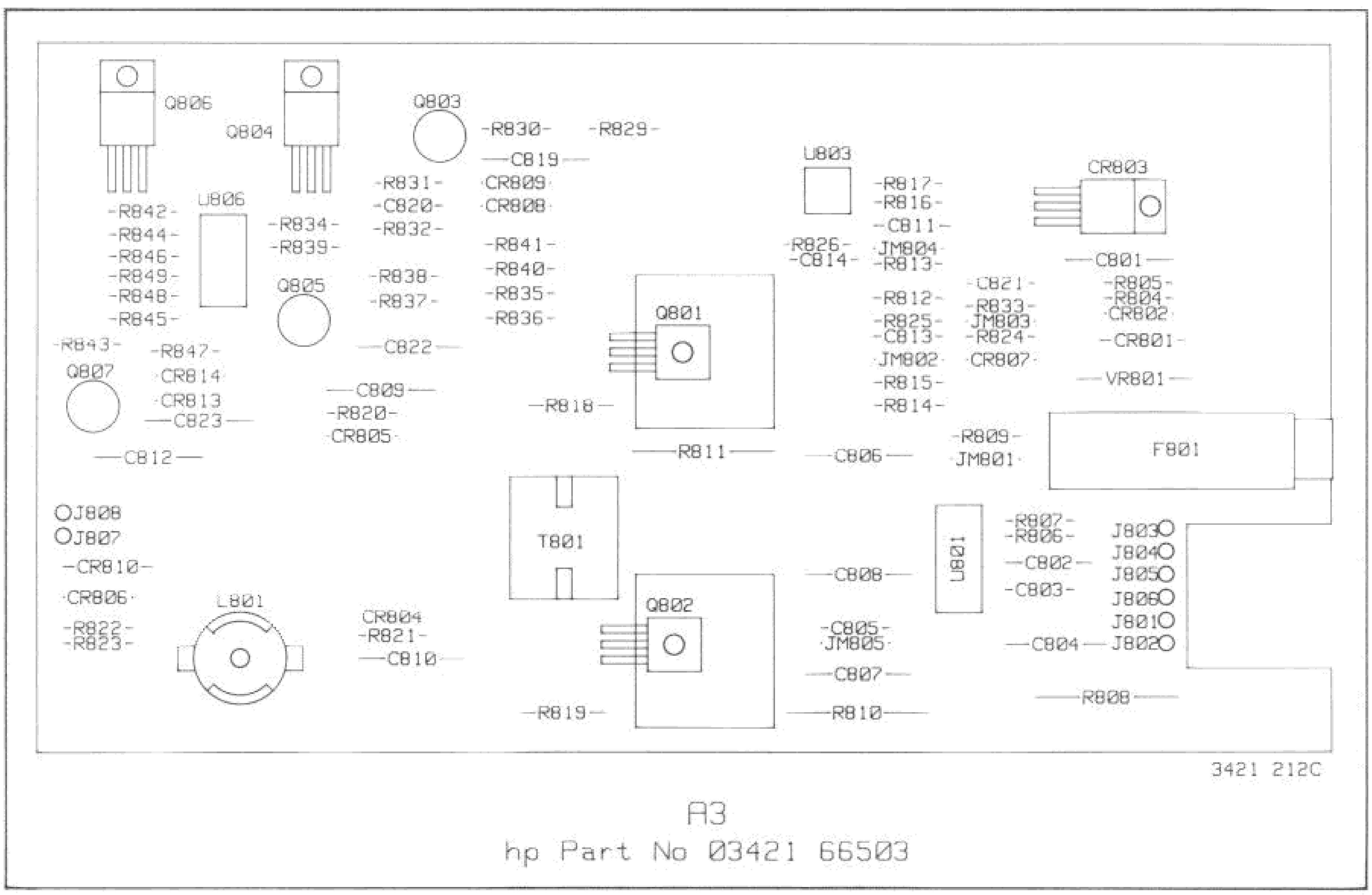



**Figure 5-7-2. Component Locator for Option 212 Assemblies**

### Table 1-6-7 (Replaceable Parts) Changes

Do the changes to Table 1-6-7 as shown in Table 5-7-1.

**Table 5-7-1. Changes to Table 1-6-7 (Change 1)**

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| Change: | | | | | | |
| A3 | 03421-66503 | 7 | 1 | 12 VDC BATTERY OPTION BOARD (ERC 2332) | 28480 | 03421-66503 |
| C813 | 0160-4822 | 2 | 2 | CAPACITOR-FXD 1000PF +-5% 100VDC CER | 28480 | 0160-4822 |
| CR808 | 1901-0050 | 3 | 2 | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| R817 | 0757-0449 | 9 | 1 | RESISTOR 20K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-2002-F |
| Delete: | | | | | | |
| C822 | 0180-0309 | 4 | 2 | CAPACITOR-FXD 4.7UF +-20% 10VDC TA | 0420J | 150D475X0010A2 |
| C823 | 0180-0309 | 4 | | CAPACITOR-FXD 4.7UF +-20% 10VDC TA | 0420J | 150D475X0010A2 |
| CR811 | 1902-3054 | 5 | 2 | DIODE-ZENER 3.65V +-5% | 28480 | 1902-3054 |
| CR812 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| CR813 | 1902-3054 | 5 | | DIODE-ZENER 3.65V +-5% | 28480 | 1902-3054 |
| CR814 | 1901-0050 | 3 | | DIODE-SWITCHING 80V 200MA 2NS DO-35 | 28480 | 1901-0050 |
| U804 | 1853-0409 | 3 | 2 | TRANSISTOR PNP SI DARL TO-220AB PD=60W | 28480 | 1853-0409 |
| U805 | 1854-0071 | 7 | 2 | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| U806 | 1853-0409 | 3 | | TRANSISTOR PNP SI DARL TO-220AB PD=60W | 28480 | 1853-0409 |
| U807 | 1854-0071 | 7 | | TRANSISTOR NPN SI PD=300MW FT=200MHZ | 28480 | 1854-0071 |
| R834 | 0757-0449 | 9 | | RESISTOR 20K 1% .125W F TC=+-100 | 24546 | C4-1/8-TO-2002-F |
| R835 | 0698-4472 | 7 | 4 | RESISTOR 7.68K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-7681-F |
| R836 | 0757-0465 | 6 | 4 | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1003-F |
| R837 | 0698-8177 | 7 | 2 | RESISTOR 1.5 5% .25W | 28480 | 0698-8177 |
| R838 | 0698-4472 | 7 | | RESISTOR 7.68K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-7681-F |
| R839 | 0757-0465 | 6 | | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1003-F |
| R840 | 0698-6963 | 5 | 2 | RESISTOR 5.55K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5551-F |
| R841 | 0698-6320 | 8 | 2 | RESISTOR 5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5001-F |
| R842 | 0757-0449 | 9 | | RESISTOR 20K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-2002-F |
| R843 | 0698-4472 | 7 | | RESISTOR 7.68K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-7681-F |
| R844 | 0757-0465 | 6 | | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1003-F |
| R845 | 0698-8177 | 7 | | RESISTOR 1.5 5% .25W | 28480 | 0698-8177 |
| R846 | 0698-4472 | 7 | | RESISTOR 7.68K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-7681-F |
| R847 | 0757-0465 | 6 | | RESISTOR 100K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-1003-F |
| R848 | 0698-6963 | 5 | | RESISTOR 5.55K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5551-F |
| R849 | 0698-6320 | 8 | | RESISTOR 5K 1% .125W F TC=0+-100 | 24546 | C4-1/8-TO-5001-F |
| Add: | | | | | | |
| C815 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| C816 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| C817 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| C818 | 0160-4571 | 8 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0160-4571 |
| R827 | 0811-3143 | 9 | 2 | RESISTOR 10 1% 3W PW TC=0+-20 | 28480 | 0811-3143 |
| R828 | 0811-3143 | 9 | | RESISTOR 10 1% 3W PW TC=0+-20 | 28480 | 0811-3143 |
| U804 | 1826-1092 | 5 | 2 | IC-VR SEL 7885C | 28480 | 1826-1092 |
| U805 | 1826-1092 | 5 | | IC-VR SEL 7885C | 28480 | 1826-1092 |

# SECTION VIII
# SERVICE

**WARNING**

*The information in this manual is to be used by qualified service trained individuals only. To avoid personal injury, do not perform any procedures in this manual, or perform any servicing of the instrument or its options, unless you are trained in electronic circuitry and understand the hazards involved.*

*The HP 3421A uses latching relays on the Multiplexer/Actuator Option (020, 021, or 022) and on the mainframe. The state of these relays can only be altered under program control. This is an advantage in the sense that, under most conditions of failure, the relays will remain in whatever state your program has set them. However, in case of power or equipment failure, any application requiring a failsafe method of insuring that circuits under control are in a known state must be provided by the installer.*

*If a Multiplexer/Actuator Assembly is installed in the HP 3421A, dependent on the configuration, any voltage connected to the assembly may also appear on the Model 3421A's front panel terminals. Make sure you do not touch the terminals if any high voltage is connected to the assembly, or personal injury can result.*

## 5-8-1. INTRODUCTION

5-8-2. This section contains the theory of operation and repair information for the 12 Vdc Power Adapter Option.

## 5-8-3. THEORY OF OPERATION

5-8-4. The theory of operation consists of block diagram and schematic diagram descriptions.

### 5-8-5. Block Diagram Description

5-8-6. Refer to the block diagram of Figure 5-8-11 for the following discussion.

5-8-7. This option is designed to operate from an external power source that can supply voltages between 11.5 Vdc and 15.3 Vdc. The external source voltage is used to generate the battery charge voltage for the HP-71B Handheld Computer (9.5 Vdc to 10.5 Vdc), the HP 9114B Disk Drive and the HP 2225B ThinkJet Personal Printer (9.9 Vdc to 10.5 Vdc). The external source voltage also develops HBATT (10.5 Vdc to 14.8 Vdc) which is used as the on-board power supply for various circuitry in the option.

5-8-8. The 10 Vdc - 14 Vdc generated by this option power for the HP 3421A mainframe. It is generated by a switching regulator type supply and is made up of the following blocks:

Switching Frequency Control
Output Drivers
Output Transformer
Output Rectifier and Filter
Output Feedback
External Low Voltage Detect
Current Limit

**5-8-9. Switching Frequency Control.** This circuitry serves as the oscillator for the switching power supply. It outputs two sets of pulses. The width of the positive postion of these pulses determines the magnitude of the output voltage. That is, the output voltage increases as the positive pulse widths increase; the output voltage decreases as the positive pulse widths decrease.

**5-8-10. Output Drives.** The output drivers consists of two transistors that are configured as a push-pull amplifier. These two transistors accept the two sets of pulses from the switching frequency control and alternately drive the output transformer.

**5-8-11. Output Transformer.** This stage transformer couples the output of the driver stage to the output rectifier and filter. This stage also isolates the ground references between the 12 Vdc Power Adapter Option and the HP 3421A mainframe.

**5-8-12. Output Recifier and Filter.** This circuitry rectifies and filters the signal received from secondary of the output transformer. The resulting dc voltage (10 Vdc to 14 Vdc) is routed to the HP 3421A mainframe. For this voltage to be between 10 Vdc and 14 Vdc, the 12 Vdc Power Adapter Option connections to the HP 3421A motherboard must be in place. These connections place the output voltage across the 1100 $\mu$F motherboard capacitor (C700) which, along with the load provided by the HP 3421A, are necessary to guarantee that the voltage will be within the 10 Vdc and 14 Vdc range.

**5-8-13. Output Feedback.** This circuitry monitors the voltage of the output stage. If the output voltage tends to go low, a signal is fed back to the switching frequency control circuitry which causes the period of the positive pulses to increase. This brings the output voltage back up to a normal level. If the output voltage tends to go high, the feedback signal decreases the positive period of the pulses, thereby lowering the output voltage.

**5-8-14. External Low Voltage Detect.** This circuitry is used to turn off the output pulses of the switching frequency control which the external source voltage is too low. If these pulses are turned off, the output voltage drops to 0 V.

**5-8-15. Current Limit.** This circuitry monitors the output of each cycle of the driver stage. If the output of the driver stage is excessive, it will turn off the pulse for the next cycle, thereby limiting the current. If an excessive load is placed across the output (e.g., a short), this circuitry will turn off the output pulses of the switching frequency control, which in turn will lower the output voltage to 0 V.

### 5-8-16. Schematic Diagram Description

5-8-17. Refer to Figure 5-8-12 for the description of the following circuitry.

Input Circuitry
Crowbar
Disc Drive and Printer Supplies
HP-71B Supplies
Switching Frequency Control
Output Drivers
Output Rectifier and Filter
Output Feedback
Current Limit
External Low Voltage Detect

**5-8-18. Input Circuitry.** This circuitry consists of the rear panel connector for the external voltage source, balun coil L802, fuse F801, transorb VR801, and diode CR801. In addition to providing a connection path to the external voltage source, it also serves as an input protection circuit, and operates in conjunction with the crowbar circuit.

5-8-19. The L802 balun coil provides suppression of radio frequency interference (RFI). Transorb VR801 is bipolar and is used to clamp noise spikes from the external source. CR801 is a pass diode which allows the external voltage source to power the 12 Vdc Power Adapter Option, but will not allow current to flow back to the external source. Fuse F801 works in conjunction with the crowbar circuit, which is explained in the next paragraph.

**5-8-20. Crowbar.** This circuitry will open the path to the external voltage source if the external voltage is too high, or when VR801 fails to suppress certain repetitive noise spikes. This is done by turning on CR803, which effectively places a short across the input terminals and causes F801 to blow.

5-8-21. Zener diode CR802 sets the threshold voltage to turn on CR803. CR803 will turn on when the external source voltage is somewhere between 16.01 Vdc and 16.86 Vdc.

5-8-22. In addition to the protection for high external dc voltages, there is protection for excessive noise spikes that do not get clamped by VR801, such as those generated by a defective automobile alternator. Resistor R805 and capacitor C801 set a time constant which will cause certain repetitive noise spikes to turn on CR803. As previously explained, when CR803 turns on fuse F801 will blow.

5-8-23. HBATT is the external source voltage minus the drop across CR801. It is used to generate the battery charging voltages for the HP 9114B Disc Drive, HP 2225B Think Jet-Printer, and HP-71B computer. HBATT is also used to power various circuitry in the power adapter option.

**5-8-24. Disc Drive and Printer Charger Power Supplies.** Since both of these supplies are the same, only one supply is explained. The supplies generate a voltage between 10.5 Vdc and 11 Vdc. Typically, the voltages are about 10.75 Vdc (no load), but can vary dependent on the external source and reference voltage. If the output voltage goes low (ie, a load is applied to the output), the output of U806b (U806d) attempts to go high and turns on Q805 (Q807) harder. This turns on darlington pair Q804 (Q806) harder and increases the output current. The power supply currents are limited by U806a (U806c) and R837 (R845). When the current is too large (>500 mA), the resultant voltage drop across R837 (R845) then sets the output of U806a (U806c) low. The low then turns off Q805 (Q807) which turns off the Q804 (Q806) darlington pair.

**5-8-25. HP-71B Battery Charger Power Supply.** This power supply generates 10 Vdc ($\pm$.5 V). If this voltage goes too low, the output of U802d goes low. This provides more base drive to Q803 increasing the current to the load.

5-8-26. CR808 and CR809 provide short circuit current protection. If a short appears across the output of this supply, these diodes will limit the current to about 50 mA.

**5-8-27. Switching Frequency Control.** This stage generates two sets of pulses which serve as the oscillator for the switching power supply. These pulses are generated at U801 pin 11 (OUT A) and U801 pin 14 (OUT B). The two sets of pulses are 180° out of phase. The width of the positive portion of the pulses determines the magnitude of the output voltage. If the period of the positive portion increases, the output voltage increases; if the period decreases the output voltage decreases.

5-8-28. At turn on, U801 pin 8 (SOFTSTART) is low. This keeps the output pulses of U801 turned off. When C805 charges, the output pulses are turned on. The current limit and external low voltage detect circuitry, which also connects to the SOFTSTART input, is explained in paragraphs 5-8-40 and 5-8-44, respectively.

5-8-29. Capacitor C802 and resistor R806 connect between U801 pins 5 and 6 (RT and CT). These two inputs set the charge time of the output pulses. R807 sets the idle time between charge states.

5-8-30. U801 pin 1 (−IN) is used to control the output voltage via the U803 feedback loop. If the output voltage tends to go low, the low is sensed at the −IN input which causes the positive pulse width of the output pulses to increase. Similarly, if the output voltage tends to go high, this input will cause the positive pulse width of the output pulses to decrease.

5-8-31. C806 is connected between U801 pin 9 (COMP) and ground. This capacitor is required to control the open loop gain of an internal error amplifier which helps regulate the pulse width of the output pulses.

5-8-32. U801 pin 10 (SHUTDOWN) is an active high input which will turn off the output pulses. This pin is connected to ground so that the outputs are never turned off via this input.

5-8-33. C807 and C808 improve the switching speed of the output drivers. R810 and R811, along with R808, set the value of the base current for the Q801 and Q802 drivers.

**5-8-34. Output Drivers.** This circuitry consists of Q801, Q802, and the primary of T801. The output pulses from the switching frequency control circuit are routed to the bases of Q801 and Q802. These transistors alternately drive the primary of T801. The feedback path for the current limit circuitry is explained in paragraph 5-8-39.

**5-8-35. Output Rectifier and Filter.** This circuitry is a full wave rectifier and filter stage. It is important to note that the ground reference for this circuitry is mainframe ground. This means that when using a test instrument to check this circuitry, the test instrument must be referenced to mainframe ground. Do not reference the test instrument to ground on the 12 Vdc Power Adapter Option. Although mainframe ground is accessible on the 12 Vdc Power Adapter Option at J808, it is more conveniently accessed at the GND test point on the motherboard.

5-8-36. The transformer coupled signals from the driver stage are rectified by CR804 and CR805, and filtered by L801 and C812. The output voltage may not be within the specified limits (10 Vdc - 14 Vdc) unless the output is connected across the 1100 $\mu$F mainframe capacitor (C700).

5-8-37. The RC network consisting of R820/C809 and R821/C810 provides damping to suppress ringing that might occur on the secondary of the transformer.

5-8-38. CR806 and R822 are used to monitor the output voltage for the output feedback loop (see paragraph 5-8-39).

**5-8-39. Output Feedback.** This circuitry helps regulate the output voltage by providing a voltage feedback path to U801 pin 1 (−IN) via the U803 optoisolator. If the output voltage tends to go low, the diode between U803 pin 2 and 3 conducts less. This reduces the base drive to the optoisolator transistor, thereby reducing the voltage at U803 pin 5. This lower voltage is sensed at U801 pin 1, which causes the period of the positive portion of the output pulses to increaase. This raises the output voltage back to a normal value. If the output voltage tends to go high, the optoisolator diode conducts more. This provides more base drive to the optoisolator transistor, thereby increasing the voltage at U803 pin 5. This higher voltage is sensed at U801 pin 1 which causes the period of the positive portion of the output pulses to decrease, whcih in turn lower the output voltage.

**5-8-40. Current Limit.** This circuitry monitors the voltage at the emitters of driver transistors Q801 and Q802 for each cycle. A cycle is defined as the on time for one of the driver transistors (either Q801 or Q802).

5-8-41. During normal operation, the emitters of Q801 or Q802 never reach a voltage that is high enough to cause the output of either the U802B or U802C comparators to go low. Thus, the SOFTSTART input to U801 is held high and will not interfere with normal circuit operation.

5-8-42. When excessive current is drawn, the voltage on the emitter of either Q801 or Q802 will increase to the point where the output of either U802B or U802C will go low (the one that goes low will depend upon the cycle). This low is sensed by U801 pin 8 (SOFTSTART) which turns off the base drive for that transistor. When the base drive is removed, transformer T801 is not pulsed, thereby reducing the current to the load. Also, when the base drive to the transistor is turned off, the U802 comparator output again goes high to release the SOFTSTART line. U801 then resets and attempts to start up again. If the excessive load is still across the output, the shut-down occurs again.

5-8-43. C814/R826 and C813/R825 provide noise filtering to prevent a false trigger of the U802 comparators.

**5-8-44. External Low Voltage Detect.** This circuitry is used to turn off the output voltage of the switching power supply when the external source voltage is too low. HBATT, which is generated from the external voltage source, is monitored by U802a via a voltage divider network consisting of R814 and R815. If HBATT is low, the output of U802a will go low. This pulls the SOFTSTART input of U801 low which turns off the U801 output pulses. It should be noted that this circuitry will not shut down the other power supply outputs when a low external source voltage is detected. It only turns off the switching power supply, which is the supply that draws the most current.

## 5-8-45. TROUBLESHOOTING

5-8-46. The troubleshooting information is divided into functional areas as follows:

Recommended Equipment - paragraph 5-8-49
Pre-Troubleshooting Checks - paragraph 5-8-51
Troubleshooting Setup - paragraph 5-8-53
HBATT and VREF Voltage Checks - paragraph 5-8-55
HP-71B Computer Charger Supply Troubleshooting - paragraph 5-8-58
HP 9114B Disc Drive and HP 2225B ThinkJet Printer Charger Supply
  Troubleshooting - paragraph 5-8-60
Switching Power Supply Troubleshooting - paragraph 5-8-62
Reassembly - paragraph 5-8-72

5-8-47. Before troubleshooting the 12 Vdc Power Adapter Option, it is recommended that you familiarize yourself with the circuitry by reading the theory of operation. Additionally, always perform the pre-troubleshooting checks to make sure the problem is not an open fuse, or something external that would adversely affect the circuit operation. Also, always check HBATT and VREF before attempting to troubleshoot any of the supplies.

5-8-48. These procedures assume a high level of technical expertise on the part of the troubleshooter. That is, they will not necessarily guide you to every possible component failure. Instead, they provide you with circuit voltages and waveforms that should appear at various circuit locations when the option is operating properly. It is the troubleshooter that must determine the defective component.

### 5-8-49. Recommended Equipment

5-8-50. The following equipment is recommended to troubleshoot the 12 Vdc Power Adapter Option:

12 V External Voltage Source
Digital Voltmeter (like the HP 3468)
Oscilloscope (like the HP 1740A)

### 5-8-51. Pre-Troubleshooting Checks

5-8-52. Before troubleshooting the 12 Vdc Power Adapter Option circuitry, perform these checks:

a. Make sure the 2.5 A fuse located in the positive lead at the 12 V source is good.

b. Make sure the 2.5 A rear panel fuse is good.

c. Check the 12 V source for the proper voltage (11.5 Vdc - 15.3 Vdc). If this voltage is below 12 Vdc, the HP 3421A will probably not power up.

d. Make sure the 12 V source has good load regulation. If the external voltage drops below 12 V when it is connected to the rear panel connector, the switching power supply will probably not start up. This is true even if the voltage dropout is momentary.

e. Make sure the internal HP 3421A main battery is connected to the motherboard and that the main battery fuse (F700) is good. If the internal battery is disconnected, the switching power supply may not start up.

f. Make sure the cables going to the 12 V source, as well as the connections at the 12 V source, are good.

### 5-8-53. Troubleshooting Setup

5-8-54. To access the 12 Vdc Power Adapter Option Board, the HP 3421A's top cover and any option occupying slot 2 need to be removed. It is also recommended that the terminal block edge connectors for all installed options, if they have external connections, be removed. Use the following procedure for the troubleshooting setup.

a. Make sure the HP 3421A is turned off and ac power cord is disconnected from the instrument. Also make sure all external sources of power have been removed from the option terminal blocks.

b. Turn the instrument upside down. This is preferably done on top of a protective mat to reduce the possibility of scratching or marring the instrument case. Use a static safe mat to prevent any buildup of static electricity. Refer to Figure 5-8-1 and loosen the six screws on the instrument bottom.

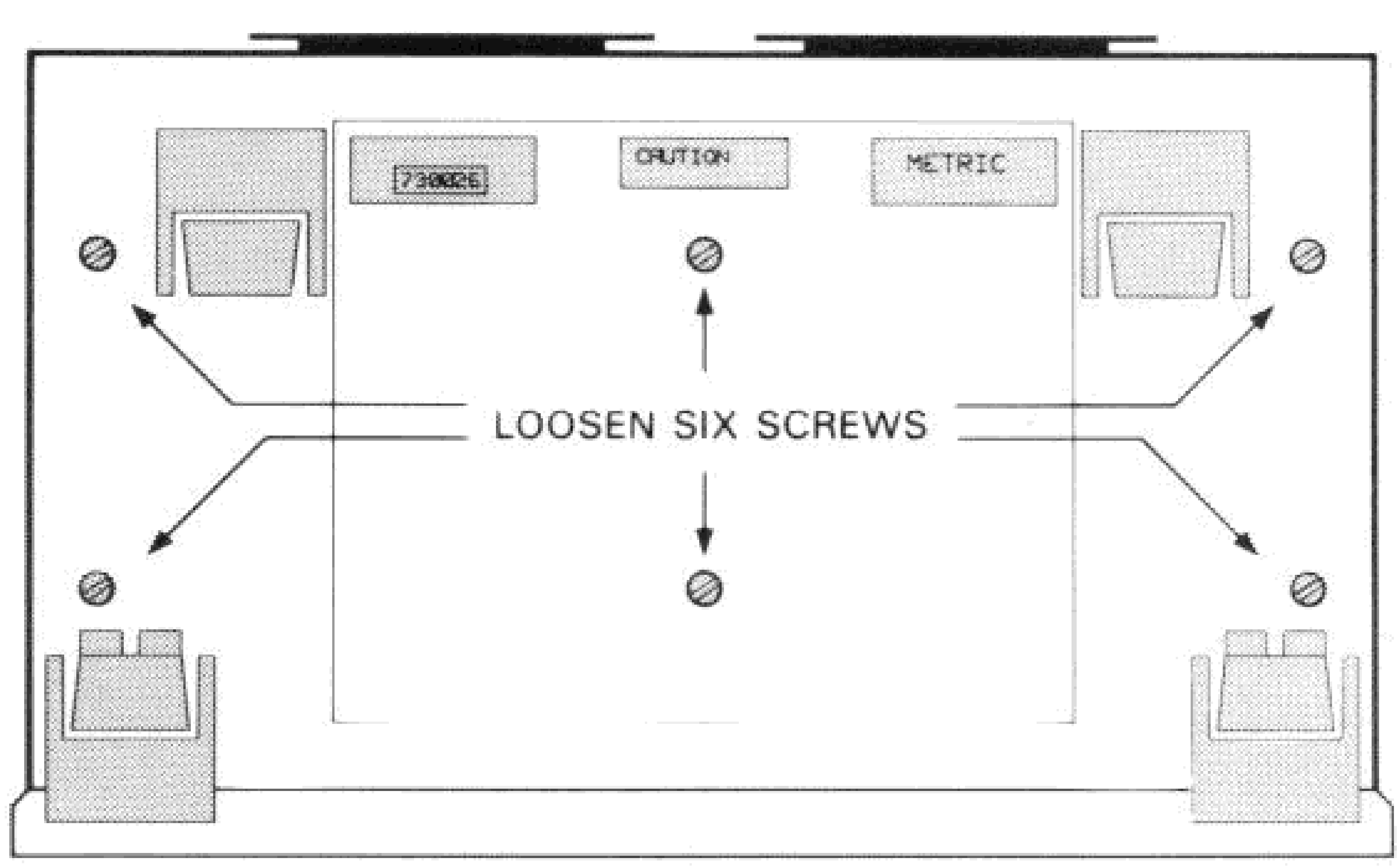



**Figure 5-8-1. Loosen Bottom Screws**

c. Hold the top cover in place and turn the instrument upright. Then remove the top cover.

d. For all installed options that have external connections, remove the strain relief, grey "WARNING" safety cover, and terminal block edge connectors as follows:

1. Remove the two screws holding the black strain relief bar.

2. Loosen the two captive screw that hold the grey "WARNING" safety cover.

3. Loosen the two screws holding the terminal block to the option circuit board and then remove the terminal block.

e. If there is no option installed in slot 2, no further disassembly is required. Go to step j. If there is an option in slot 2, continue with the following steps.

f. Make sure the black strain relief bar and grey "WARNING" safety cover are removed from the slot 2 option (see step d).

g. Refer to Figure 5-8-2 and unplug the ribbon cable connector from the option in slot 2. Lift the connector straight up to avoid bending any pins. If the option is a Multiplexer/Actuator Assembly, also unplug the 4-wire VM input cable. If the option is a Digital I/O or Breadboard Assembly, it will not have the 4-wire VM input cable.

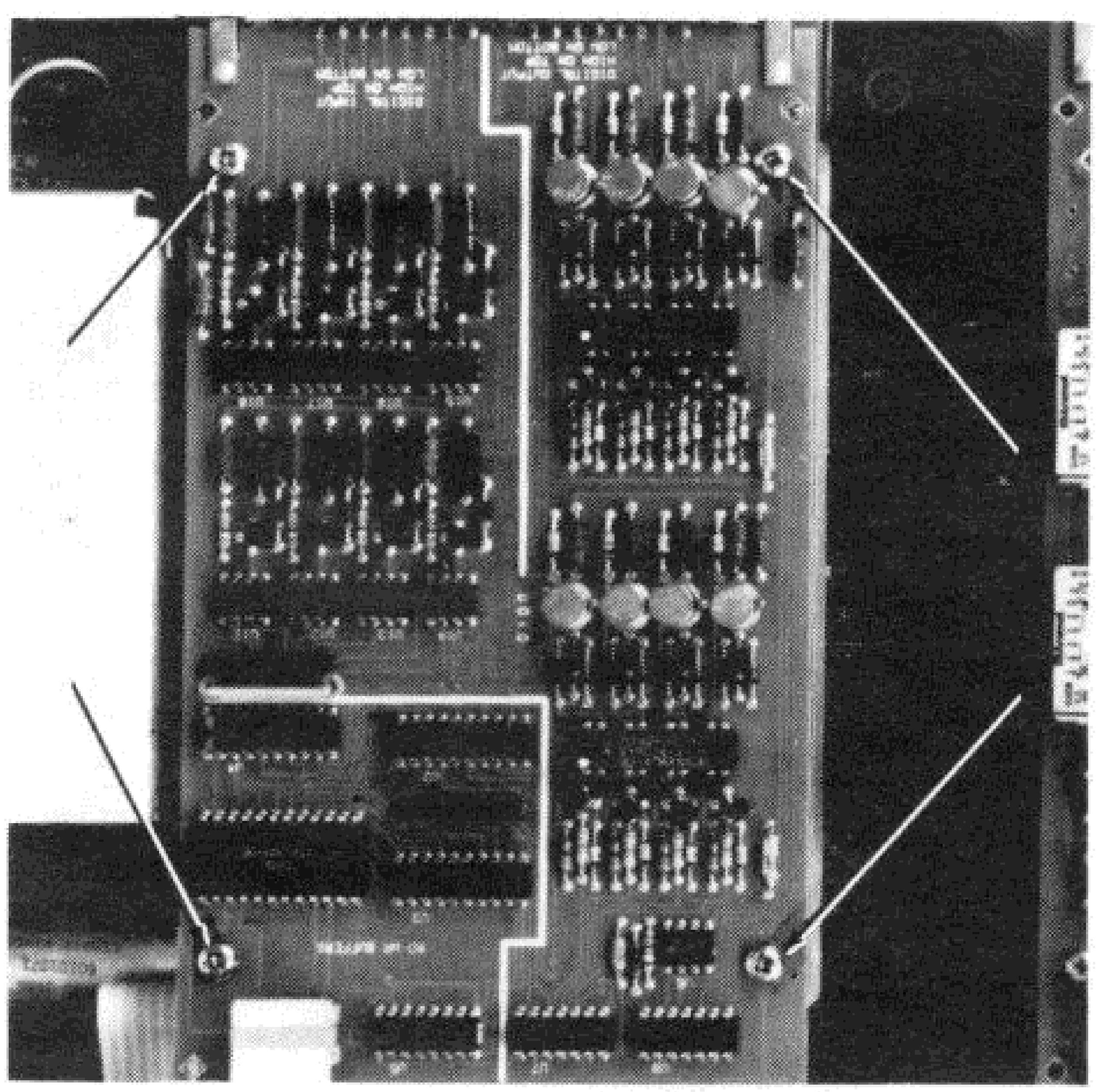


**Figure 5-8-2. Slot 2 Option Removal**

h. Locate and remove the four screws holding the option in place (see Figure 5-8-2). Then remove the option.

i. Replace the four screws that hold the 12 Vdc Power Adapter Option in place, as shown in Figure 5-8-3. This is recommended to avoid shorting any components. It does not, however, establish the ground reference for the pc board. Ground Reference is established by wire connections.

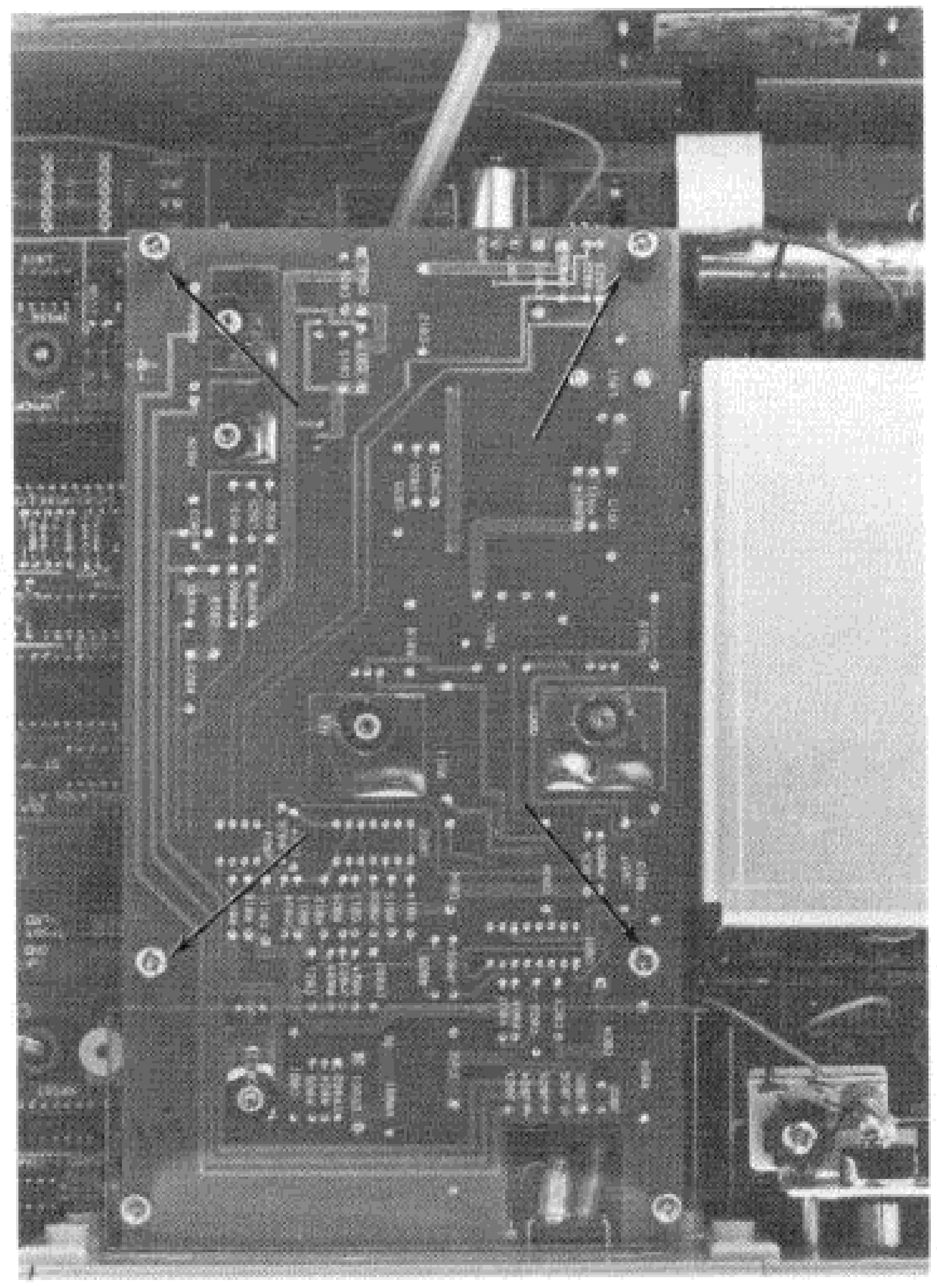


Figure 5-8-3. Securing the 12 Vdc Power Adapter Option

j. This completes the troubleshooting setup. If it is necessary to remove the 12 Vdc Power Adapter Option, remove the four screws holding it in place and lift the option out. If any wires are disconnected, refer to the reassembly procedure in paragraph 5-8-72 to determine the proper connection.

### 5-8-55. HBATT and VREF Voltage Checks

5-8-56. These voltages should always be checked before troubleshooting any of the supplies. HBATT is the external source voltage minus the drop across CR801 (.5 Vdc, dependent on the load). HBATT is used in the external low voltage detect circuit, at the center tap of T801, and to power U801 and U802. The voltage is also used to generate the power supply voltage for the HP-71B computer, HP 9114B Disc Drive, and HP 2225B ThinkJet Printer. VREF is a reference voltage developed at U801 pin 6. It is used by the low voltage detect and current limit circuits, peripheral power supplies, and by the computer power supply.

5-8-57. To check these voltages, do the following:

a. Connect the external 12 V source to the rear panel connector.

b. Connect the common lead of the digital voltmeter to the center terminal strip lug. This terminal strip is located toward the left rear of the instrument (as viewed from the front), just in front of the external 12 V source connector. The center lug has a black wire and one lead of the L802 balun coil soldered to it. This will reference the test instrument to ground on the 12 Vdc Power Adapter Option.

**NOTE**

*The external source voltage is checked in the next step. This voltage can be between 11.5 Vdc and 15.3 Vdc. However, the switching power supply will not start up unless this voltage is 12 Vdc or greater. See paragraph 5-8-65 for an explanation.*

c. With the positive lead of the voltmeter, probe the terminal strip lug with the red wire soldered to it. At this location, you should read the external source voltage (11.5 Vdc - 15.3 Vdc). If this voltage is correct, proceed with step d. If this voltage is non-existent, either the balun coil is open or there is a defective connection to the external source.

d. Use the positive lead of the voltmeter and check HBATT at CR803 pin 2. An illustration of the CR803 pin assignments is shown on the schematic. Remember, however, that you are looking at the bottom side of the pc board. A convenient location to probe CR803 pin 2 is on the screw and nut that is used to mount the component. HBATT should be no more than .5 V lower that the external source voltage. For example, if the external source voltage is 12.5 Vdc, HBATT should be a minimum of 12 Vdc. If this voltage is OK, proceed with step e. If HBATT is non-existent, CR801 is probably open or F801 is blown. If F801 keeps blowing, there is most likely a defective component in the crowbar circuit.

e. Now check VREF at U801 pin 16 for 5.1 V (± 1%). If this voltage is correct, but one of the power supplies is not operating properly, proceed to the troubleshooting procedures for the power supply that is bad. If VREF is incorrect but HBATT is OK, U801 is probably defective.

## 5-8-58. HP-71B Charger Power Supply Troubleshooting

5-8-59. The proper circuit voltages for this power supply are shown in Figure 5-8-4. These voltages should be measured when the supply's output is 10 Vdc at no load. The voltages may vary slightly due to component variations.

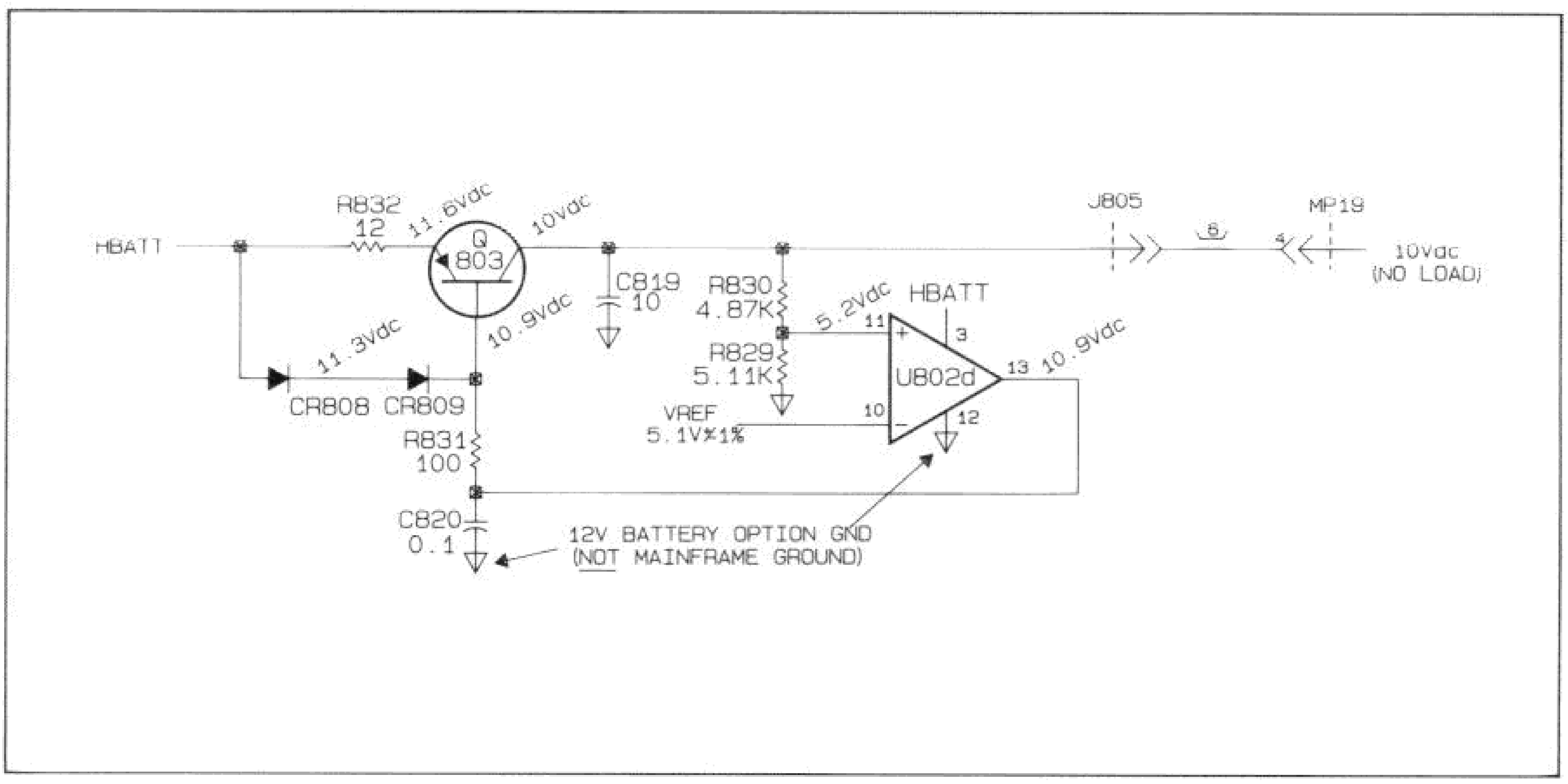



**Figure 5-8-4. HP-71B Battery Charger Power Supply Voltages**

## 5-8-60. HP 9114B Disc Drive and HP 2225B Printer Charger Supply Troubleshooting

5-8-61. The proper circuit voltages for these power supplies are shown in the simplified schematic in Figure 5-8-5. These voltages should be measured when the supply's output is 10.2 Vdc (±.3 V) at no load. The voltages may vary slightly due to component variations. Troubleshoot the circuitry by first determining the defective circuitry. Do this by lifting diode CR812 (CR814). If the power supply now operates, the current limiting circuitry is at fault. If the power supply is still inoperative, the power supply circuitry itself is at fault.

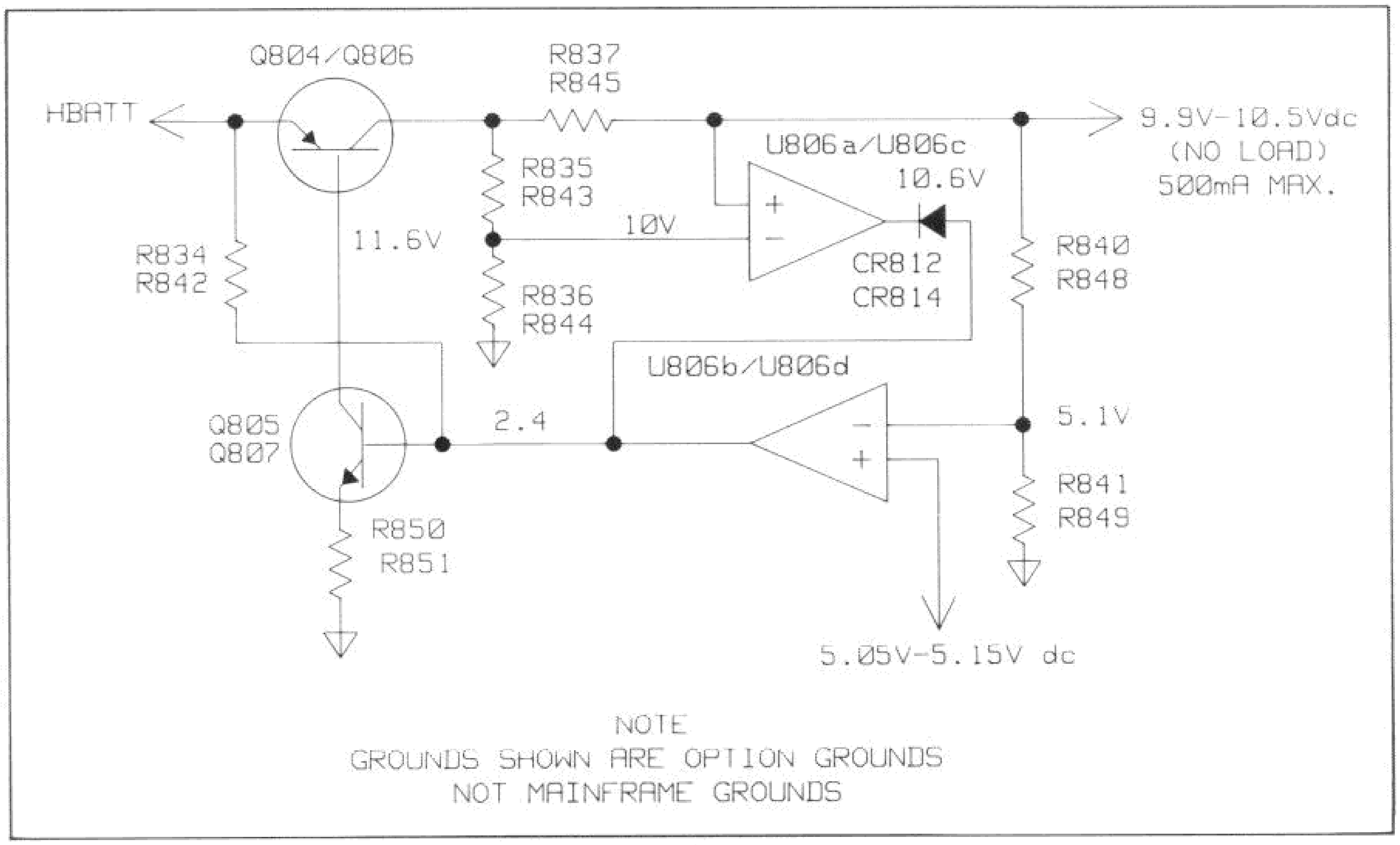



**Figure 5-8-5. Disc Drive and Printer Power Supply Voltages**

## 5-8-62. Switching Power Supply Troubleshooting

5-8-63. This power supply provides power to the HP 3421A mainframe, and is divided into the following functional blocks.

Switching Frequency Control
Output Drivers
Output Rectifier and Filter
Output Feedback
External Low Voltage Detect and Current Limit

5-8-64. One important consideration when checking this circuitry is to make sure you are using the proper ground reference. Most circuitry is referenced to ground on the 12 Vdc Power Adapter Option (see paragraph 5-8-57, step b). However, the output rectifier plus U803 pins 2 and 3, are referenced to the HP 3421A mainframe ground. Make sure your test instrument is referenced to the proper ground.

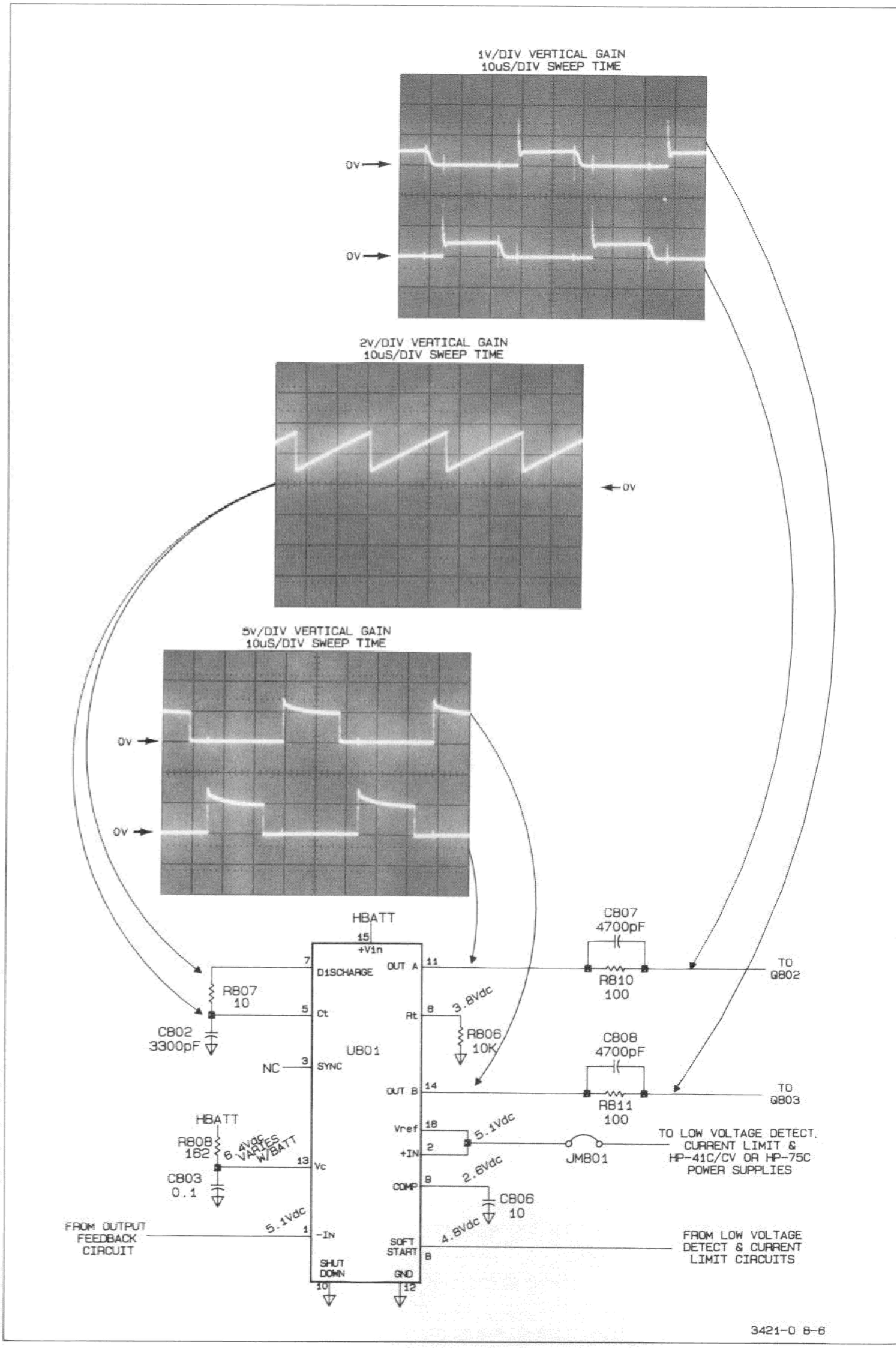



**Figure 5-8-6. Switching Frequency Control Voltages and Waveforms**

5-8-65. Before assuming the switching power supply is failing, the implications of the input voltage specifications (11.5 Vdc to 15.3 Vdc) and input hysteresis specifications (11 Vdc dropout, 12 Vdc startup) should be understood. Collectively, these two specifications imply that the switching power supply will not start unless the external voltage is 12 Vdc or greater. Once it starts, it will continue to operate until the external drops to 11 Vdc (± .2 Vdc). In addition, do not expect this supply to start even if the external voltage source has poor load regulation. For example, if the external voltage source has a no load voltage of 12.5 Vdc, but drops below 12 Vdc when plugged into the HP 3421A, the switching supply will probably not start. This is true even if the voltage dropout is momentary. When the external voltage source drops below 11.5 Vdc, the HP 9114B Disc Drive and HP 2225B ThinkJet Printer Charger Supplies will not provide enough voltage to keep the batteries charged for these peripheral devices.

5-8-66. Jumpers (JM801 - JM805) are not recommended for use as troubleshooting aids. These jumpers were used during the design stage and for production test purposes. If these jumpers are removed for troubleshooting, output regulation will also be removed. This could cause additional circuit damage (most likely to the output driver transistors), especially if the switching power supply output has a low impedance path across it.

**5-8-67. Switching Frequency Control.** The voltages and waveforms for this circuitry are shown in Figure 5-8-6. to check these, reference your test instrument to 12 Vdc Power Adapter Option ground (see paragraph 5-8-57 step b for the location of this ground). These values are approximate and were obtained with a switching power supply output voltage of 10.8 Vdc and with the HP 3421A front panel switch on.

**5-8-68. Output Drivers.** The circuit voltages and waveforms for this stage are shown in Figure 5-8-7.

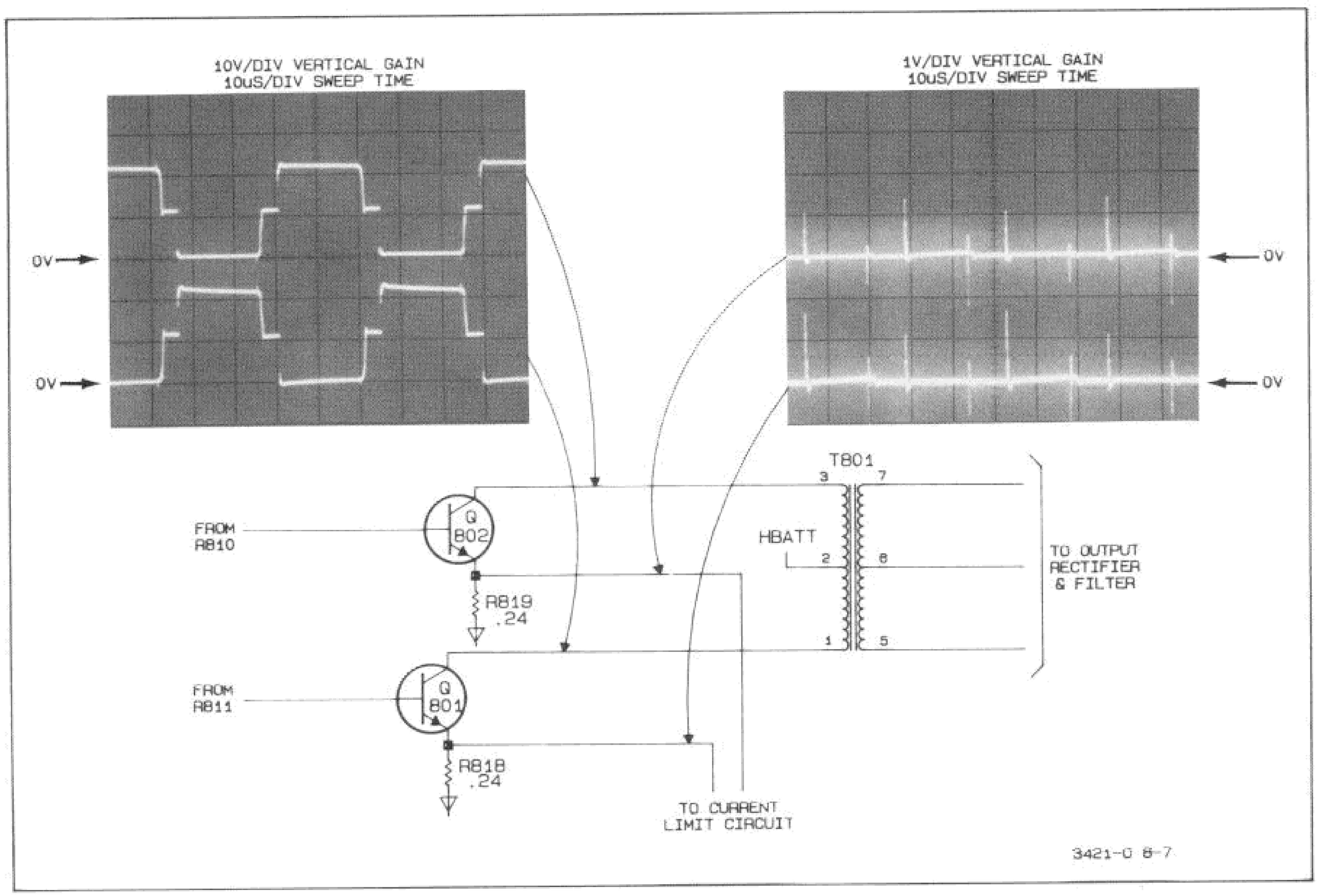



**Figure 5-8-7. Output Driver Voltages and Waveforms**

**5-8-69. Output Rectifier and Filter.** The circuit voltages and waveforms for this circuitry are shown in Figure 5-8-8, and were obtained with the HP 3421A front panel switch on. Remember to reference your text instrument to HP 3421A mainframe ground.

**5-8-70. Output Feedback.** The circuit voltages for this circuitry are shown in Figure 5-8-9, and were obtained with the HP 3421A front panel switch on. The ground reference for U803 pins 2 and 3 is mainframe ground; the ground reference for all other circuit locations is the 12 Vdc Power Adapter Option ground.

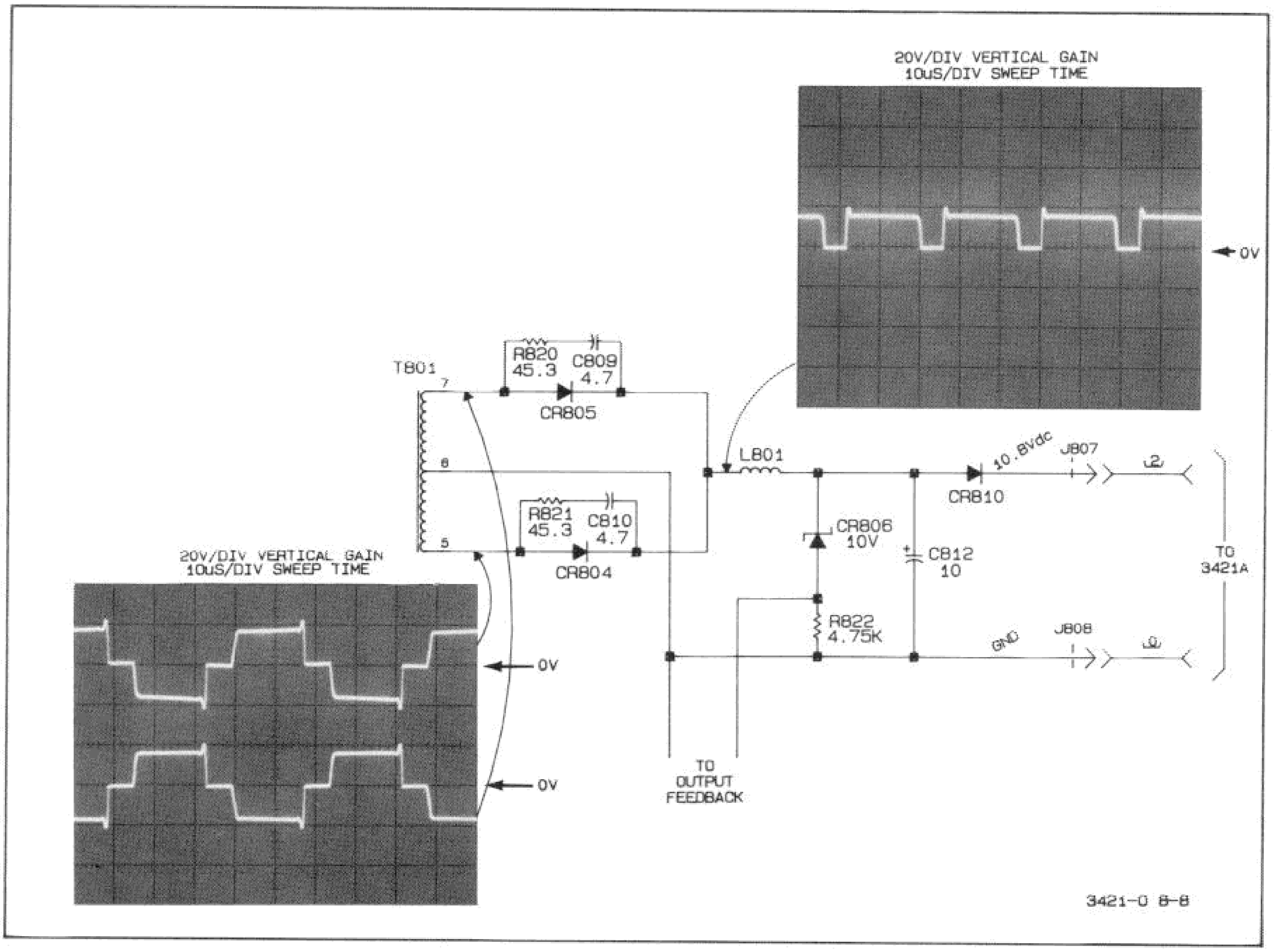



**Figure 5-8-8. Output Rectifier and Filter**

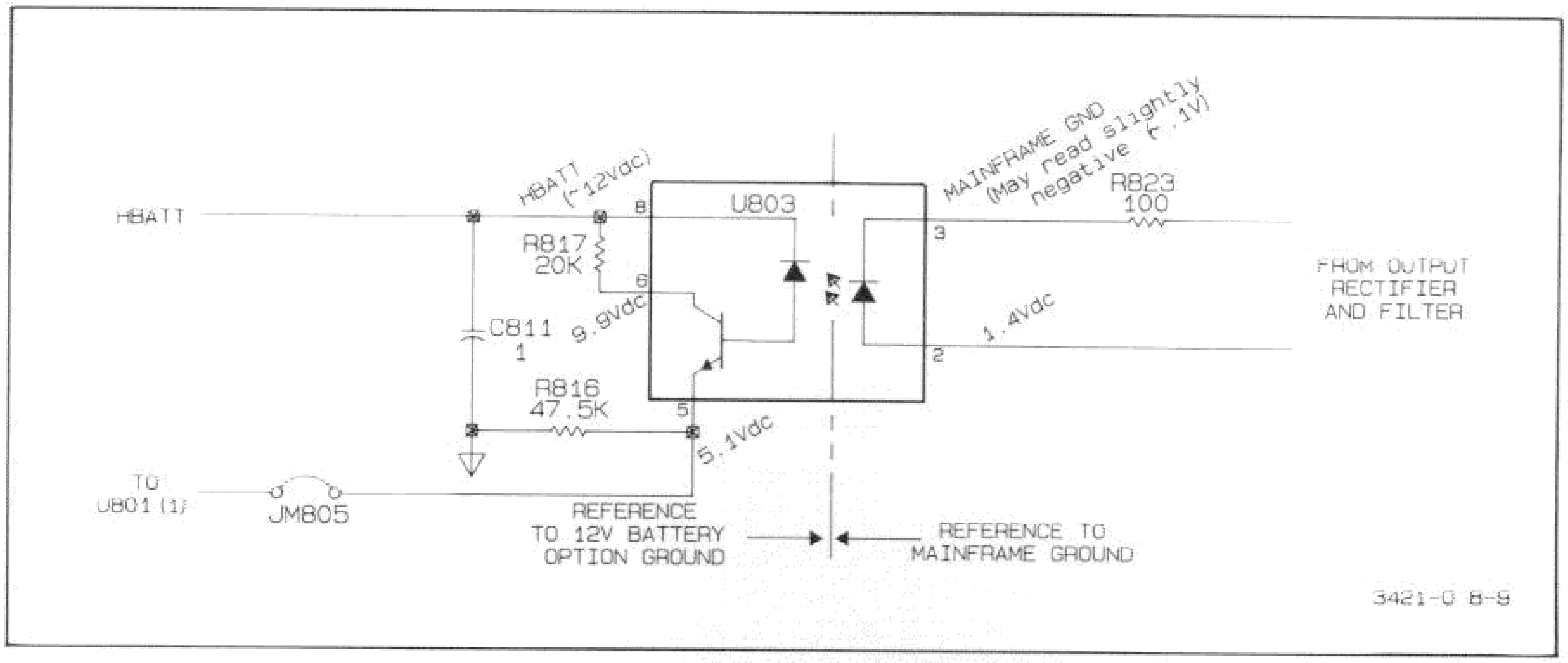



**Figure 5-8-9. Output Feedback Voltages**

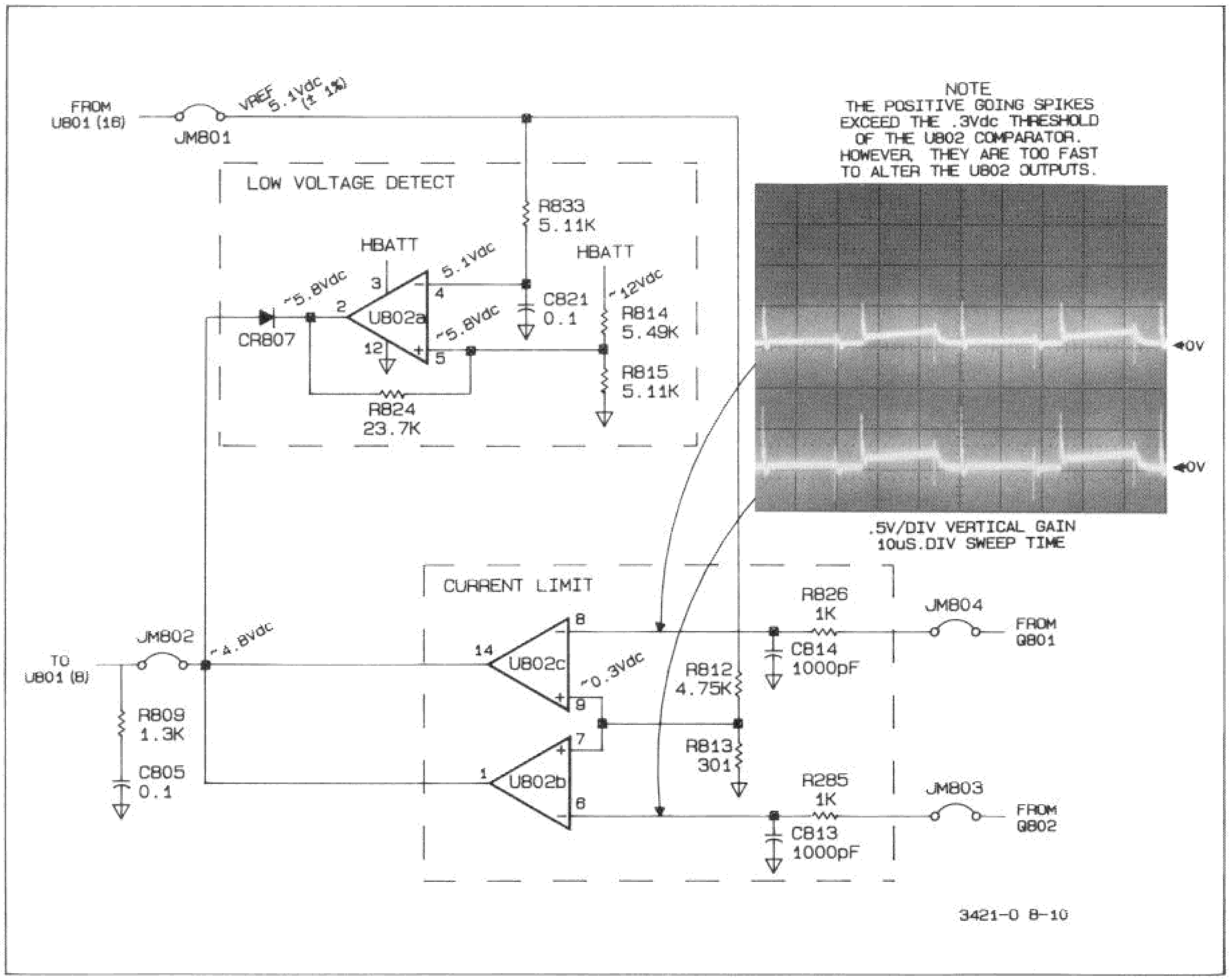



**Figure 5-8-10. External Low Voltage Detect & Current Limit Voltages and Waveforms**

**5-8-71. External Low Voltage Detect and Current Limit.** The voltages and waveforms for these two circuits are shown in Figure 5-8-10. Notice that the positive spikes appearing at U802 pins 6 and 8 exceed the .3 Vdc threshold of U802B and U802C. However, these spikes are too fast for the comparators to respond. Hence, the outputs of U802B and U802C remain high and do not cause a current limit condition. It is the period between the positive going spikes that, when they reach a level exceeding the .3 V threshold, will limit the current.

## 5-8-72. Reassembly

5-8-73. Perform the following procedure to reassemble the instrument.

a. Ensure that the various wires of the 12 Vdc Power Adapter Option are connected as follows:

Black wire between J808 on option and TP713 on motherboard

Red wire between J807 on option and TP700 on motherboard

Black wire between J802 on option and the terminal strip mounted inside rear panel (the black wire is soldered to the terminal strip)

Red wire between J801 on option and the terminal strip mounted inside rear panel (the red wire is soldered to the terminal strip)

Black wire between J806 on option and rear panel connector pin 1

Yellow wire between J804 on option and rear panel connector pin 2

Grey wire between J803 on option and rear panel connector pin 3

Blue wire between J805 on option and rear panel connector pin 4

b. Place the 12 Vdc Power Adapter Option pc board on top of the bottom shield with the component side down.

c. If no option is to occupy slot 2, secure the 12 Vdc Power Adapter Option with the four screws and proceed with step d. If an option is to occupy slot 2, do the following:

1. Set the slot 2 option in place with the component side up. Then loosely screw in the four long screws. Do not tighten the four screws at this time.

2. Plug the appropriate terminal block edge connector onto the option in slot 2.

3. Replace the rear panel "WARNING" safety cover for slot 2. Align the slot 2 option assembly so that the terminal clock edge connector lines up with the two holes in the safety cover and screw on the black strain relief bar. Do not overtighten these screws.

4. Tighten the four screws to secure the slot 2 and 12 Vdc Power Adapter Option assemblies to the mainframe.

5. Using a short cliplead jumper, connect one end of the cliplead to ground. Use the other end to short out each pin of the 14-pin connector on the option in slot 2. Then plug the ribbon cable into the option. Make sure the red stripe on the cable is oriented to the right (i.e., pin 7 of the connector). If the option in slot 2 is a Multiplexer/Actuator Assembly, connect the 4-wire VM cable onto the option. The 4-wire cable should be oriented per the label on the circuit board. On the motherboard, the 4-wire cable should be plugged onto J120 with the wires oriented as noted on the motherboard.

6. Proceed with step d.

d. Locate the six plastic spacers and place them over the cabinet screws.

e. Set the instrument flat on your workbench with the bail handles on the front feet collapsed. Align the top cover and lower it into place. Be sure the guiding grooves are properly engaging the front and rear panels. If the grooves are properly engaged but the top cover will not lower into place, one or more of the six plastic spacers is probably misaligned. To correct this, move the top cover back and forth (left and right) until the spacers align properly.

f. Once the top cover is in place, hold the two case halves together and turn the instrument upside down.

g. Tighten the six bottom screws.

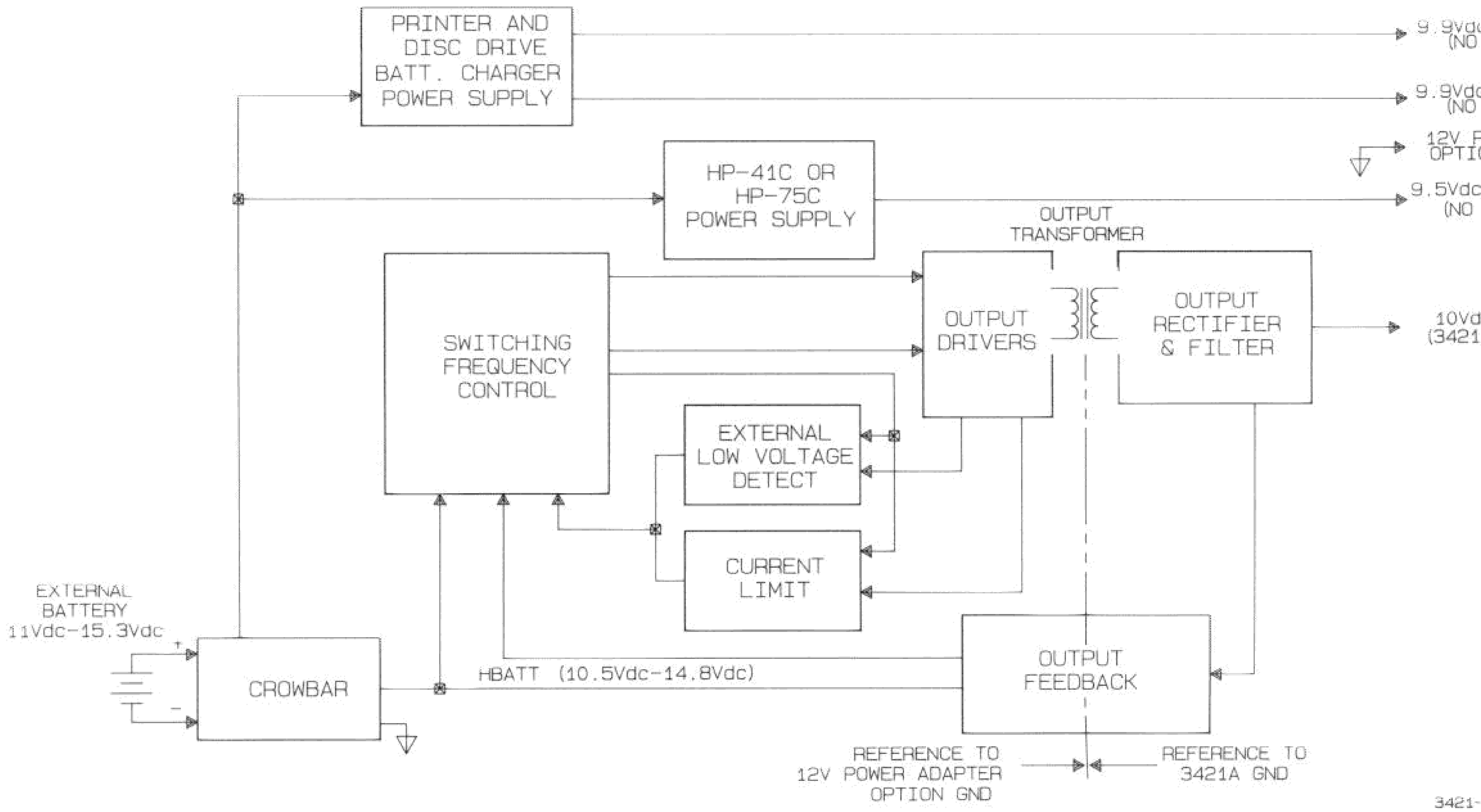



Figure 5-8-11. 12 Volt Power Adapter Option Bloc

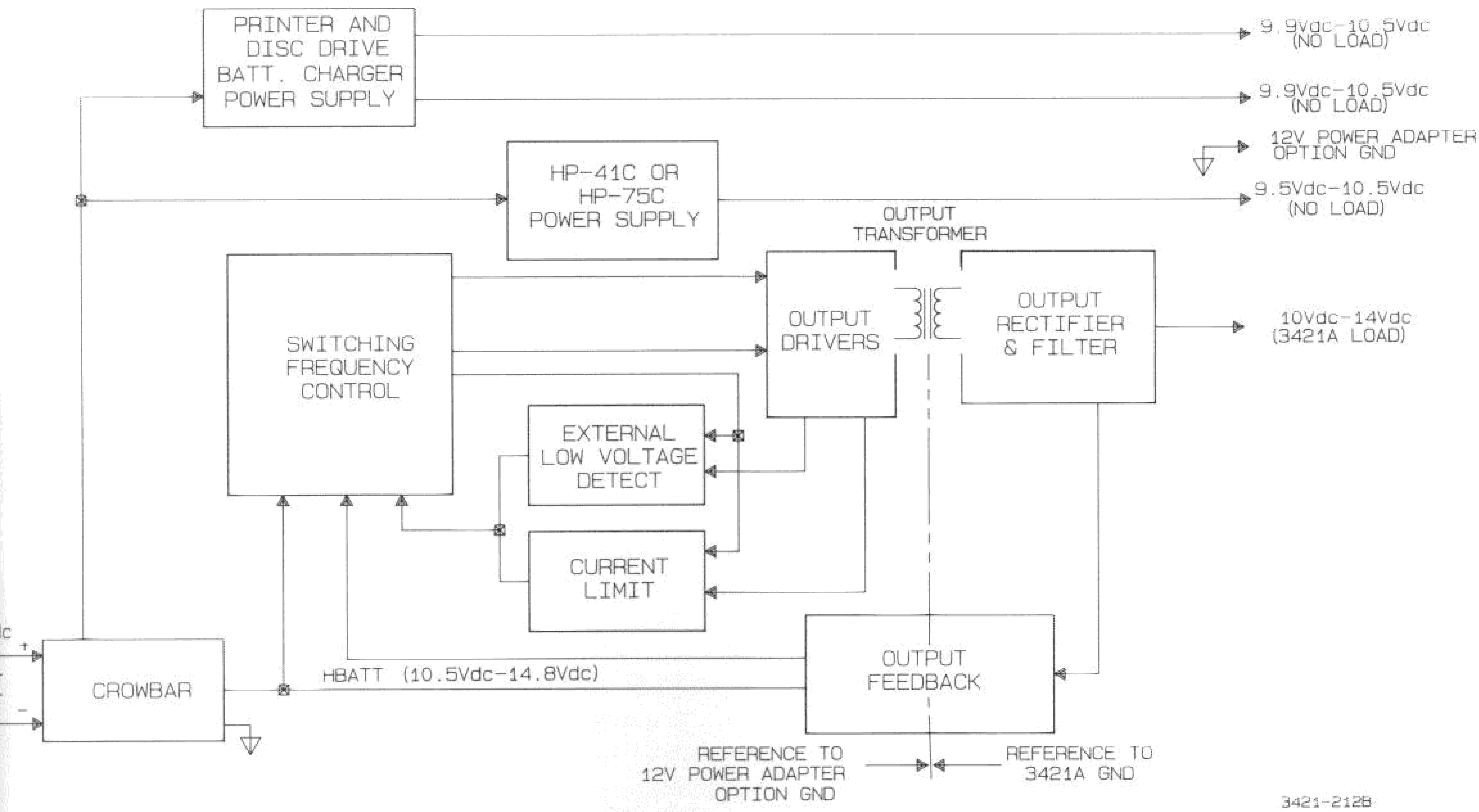
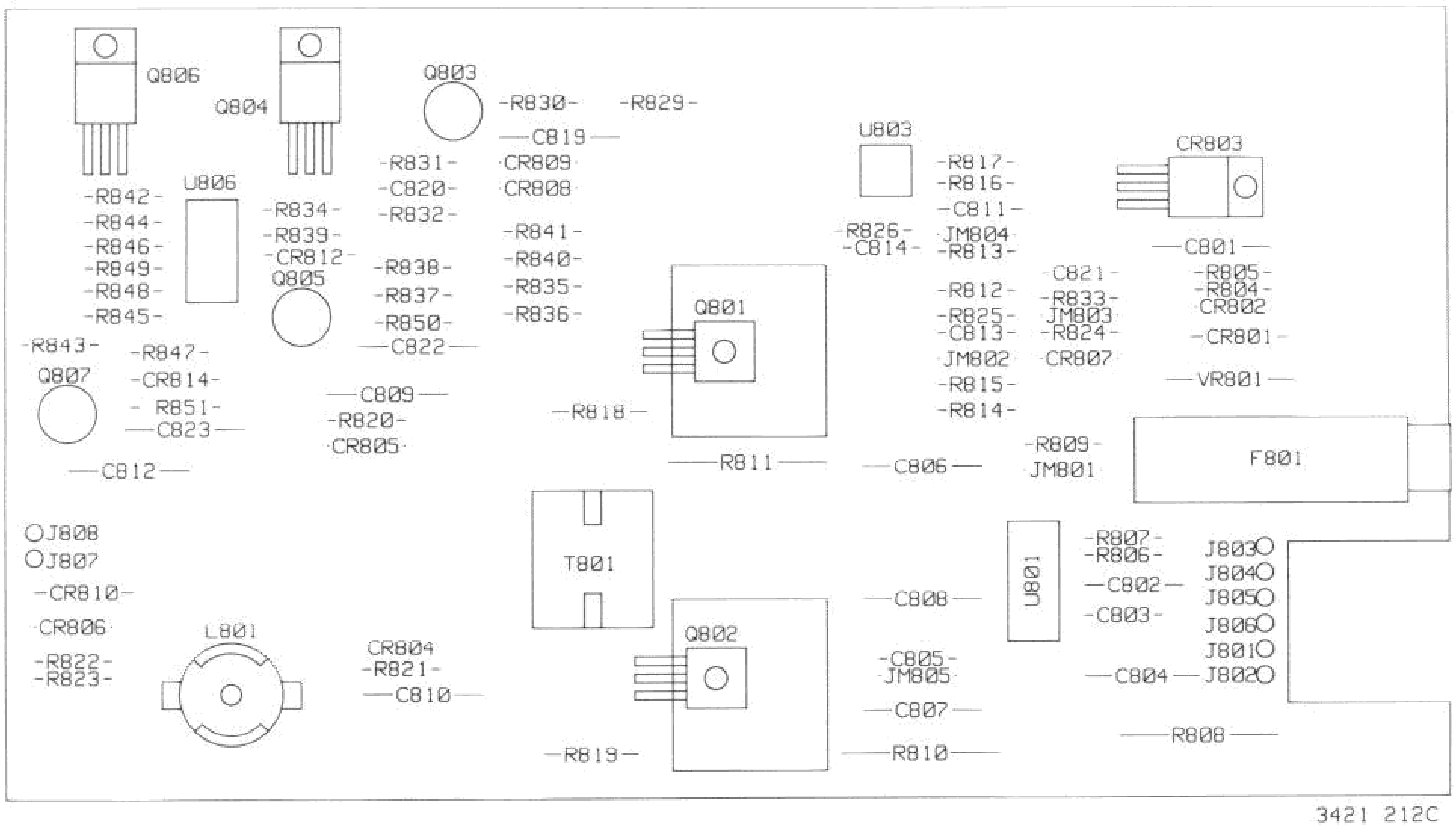
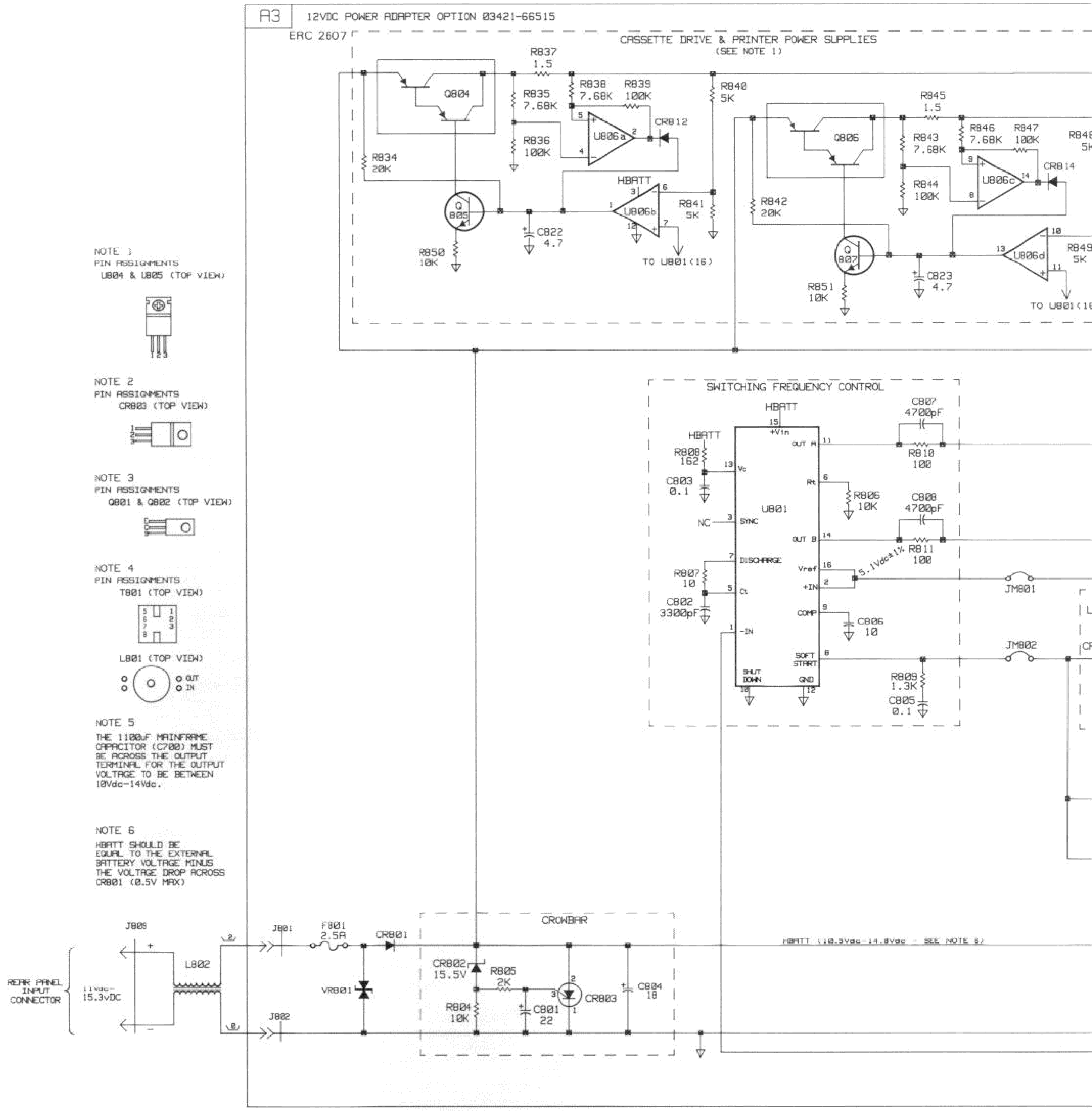



Figure 5-8-11. 12 Volt Power Adapter Option Block Diagram




HP Part Number 03421-66515


A3
12VDC POWER ADAPTER OPTION 03421-66515
ERC 2607
CASSETTE DRIVE & PRINTER POWER SUPPLIES
(SEE NOTE 1)
R837 1.5
Q804
R835 7.68K
R838 7.68K
R839 100K
R840 5K
U806a
CR812
R836 100K
R834 20K
HBATT
U806b
R841 5K
Q 805
C822 4.7
R850 10K
TO U801(16)
R845 1.5
Q806
R843 7.68K
R846 7.68K
R847 100K
U806c
CR814
R844 100K
R842 20K
Q 807
C823 4.7
U806d
R849 5K
R851 10K
TO U801(16)
SWITCHING FREQUENCY CONTROL
HBATT
+Vin
C807 4700pF
OUT A
R810 100
HBATT
R808 162
Vc
C803 0.1
Rt
R806 10K
U801
C808 4700pF
NC
SYNC
OUT B
R811 100
DISCHARGE
Vref
5.1Vdc±1%
R807 10
+IN
JM801
Ct
C802 3300pF
COMP
C806 10
-IN
SOFT START
JM802
R809 1.3K
C805 0.1
SHUT DOWN
GND
NOTE 1
PIN ASSIGNMENTS
U804 & U805 (TOP VIEW)
NOTE 2
PIN ASSIGNMENTS
CR803 (TOP VIEW)
NOTE 3
PIN ASSIGNMENTS
Q801 & Q802 (TOP VIEW)
NOTE 4
PIN ASSIGNMENTS
T801 (TOP VIEW)
L801 (TOP VIEW)
OUT
IN
NOTE 5
THE 1100uF MAINFRAME CAPACITOR (C700) MUST BE ACROSS THE OUTPUT TERMINAL FOR THE OUTPUT VOLTAGE TO BE BETWEEN 10Vdc-14Vdc.
NOTE 6
HBATT SHOULD BE EQUAL TO THE EXTERNAL BATTERY VOLTAGE MINUS THE VOLTAGE DROP ACROSS CR801 (0.5V MAX)
J809
L802
REAR PANEL INPUT CONNECTOR
11Vdc-15.3vDC
J801
F801 2.5A
CR801
VR801
J802
CROWBAR
CR802 15.5V
R805 2K
R804 10K
C801 22
CR803
C804 10
HBATT (10.5Vdc-14.8Vdc - SEE NOTE 6)

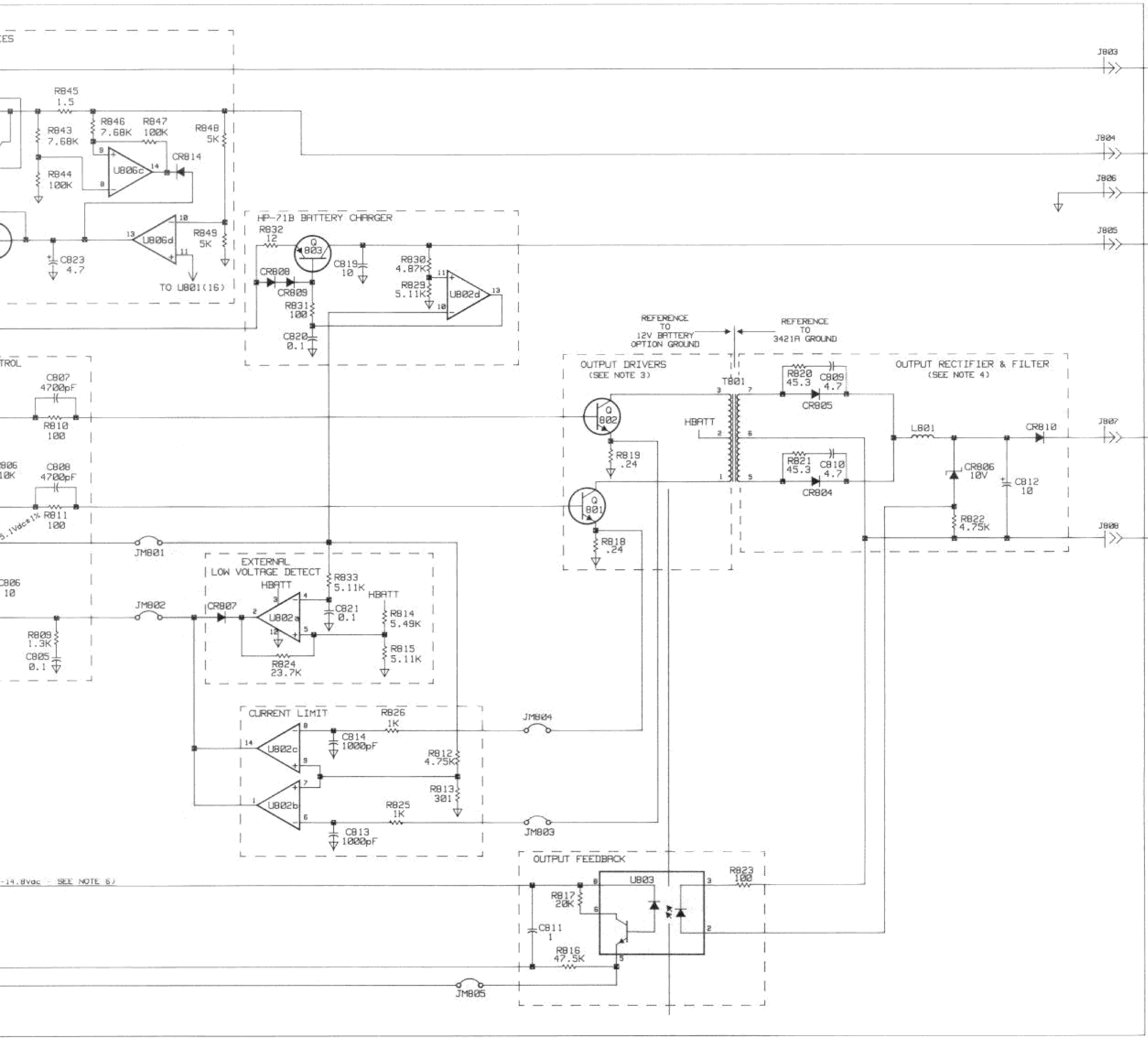



Figure 5-8-12. 12 Volt Power Adapter

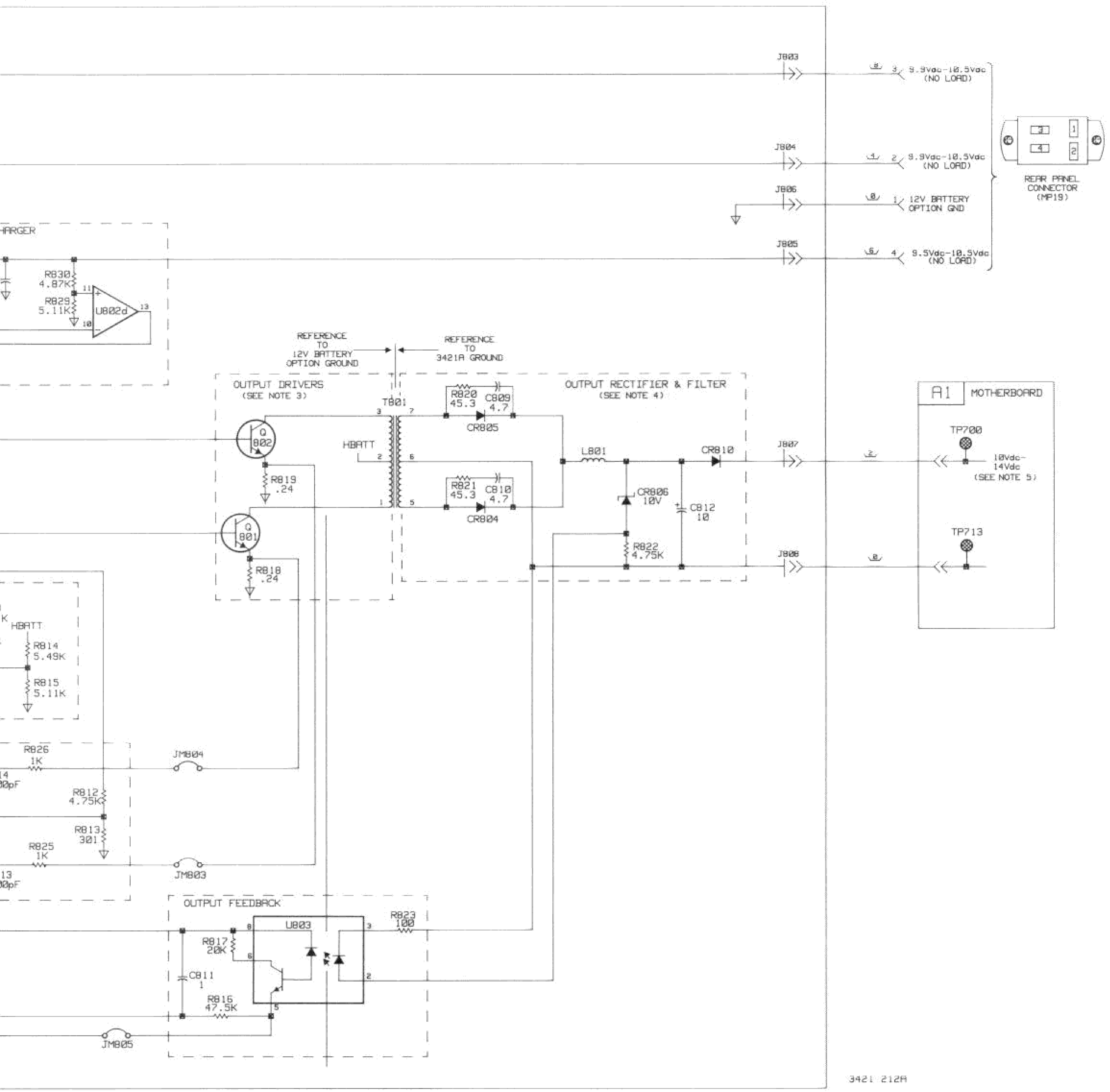


Figure 5-8-12. 12 Volt Power Adapter Option Schematic Diagram

# APPENDIX A
## Hewlett-Packard Interface Loop (HP-IL)

### A-1. INTRODUCTION

A-2. The Hewlett-Packard Interface Loop (HP-IL) is a two wire interface that permits communication between devices. All devices are connected around the loop in a serial manner (i.e., one device after another). Information travels around the loop from one device to the next in a bit serial format. The following discussion is controller independent but, where appropriate, is HP 3421A dependent.

### A-3. General HP-IL Description

A-4. The HP-IL usually consists of a system controller and as many as thirty peripheral devices. Messages travel around the loop from one device to the next. When a device receives a message that is not intended for it, it passes the message on to the next device. When the message reaches the intended device, the device responds to the message, and also passes the message on. This permits messages to be sent to, and received from, selected devices in the loop, with built-in error checking capability.

A-5. To maintain noise immunity, the maximum cable length between devices should not exceed ten metres.

### A-6. HP-IL System Terms

A-7. The following terms and concepts are used to describe HP-IL system operations.

**a. Address.** Each device in the loop is automatically assigned an address by the system controller at power on. The controller uses the addresses to specify which device in the loop will source messages and which device(s) in the loop will receive messages.

**b. Byte.** A byte is a unit of information consisting of eight binary digits (bits).

**c. Device.** Any instrument or unit that is HP-IL compatible is called a device.

**d. Device Dependent.** This type of information causes a device to perform some action. The action can be characteristic of the device, and will probably vary from device to device.

**e. Frame.** Messages are sent through the loop as a sequence of eleven bits called a message "frame".

**f. Polling.** Polling is a process typically used by a controller to locate a device that has requested service from the controller. There are two types of polling, serial poll and parallel poll.

*1. Serial Poll.* When the controller executes a serial poll, the addressed device returns it's status byte. The status byte will note the device's status and whether or not it requested service. Typically, if the device did request service, the status byte will also note why it requested service.

2. *Parallel Poll.* This method obtains a status bit from as many as eight devices in the loop. The HP 3421A does not respond to a parallel poll.

### A-8. Functional Overview

A-9. Each device in the loop may possess one or more of three basic device capabilities: controller, talker, or listener. There may be several devices in the loop that are capable of assuming controller status, but there can only be one active controller at any given time. Furthermore, there can only be one system controller. The system controller is in charge at power-on. Protocol exists within HP-IL to allow the system controller to pass control to other devices in the loop. The HP-85 Computer is an example of a device that can assume controller status, assuming it is equipped with the proper interface module. The HP 3421A cannot assume controller status.

A-10. Talker devices can source data (but not commands) to other devices in the loop. A talker sources data only when commanded to do so by the controller, and therefore must also have listen capabilities so it can configure itself as a talker. There are some instances where the loop may not have a controller. It may consist of one ''talk only'' device and another ''listen only'' device. An example of this would be a voltmeter that sends measurement results to a printer. The HP 3421A has talker capabilities.

A-11. Listeners are devices with the capability to receive and process messages. Some devices have ''listen only'' capability, which means they are not capable of ''sourcing'' messages. Sourcing, however, should not be confused with ''passing'' messages. For example, if a device is a ''listen only'' device, it is capable of passing a message on to another device, even though it does not have talker capability. The difference is that ''listen only'' devices pass messages as opposed to generating (or sourcing) messages. The HP 3421A has listen capability.

### A-12. Addressing

A-13. Each device in the loop is assigned an address at system controller power on. The assigned address will probably be different than the factory preset address of a device. The HP 3421A, for example, has a factory preset address of ''09''. If the HP 3421A is the only device in the loop with the controller, it will be assigned an address of ''01''. The address permits the controller to specify a particular device in the loop when sending commands. Addresses are assigned to devices sequentially around the loop in the direction of information flow. The first device after the controller is assigned address ''01'', the second device is assigned address ''02'', etc..

### A-14. Messages

A-15. Messages sent through the loop consist of one or more 11-bit sequences. Each 11-bit sequence is called a message frame. Message frames are asynchronous, which means they are generated in a random manner. Because of the random generation, the first bit of each frame is a sync bit so that each device can recognize the beginning of a frame. The next two bits are control bits which classify the message frame as either a command, ready, or data. The last eight bits of the message frame contain the data.

A-16. Although a message may consist of more than one frame, only one frame is in transit around the loop at any given time. In general, when a device sources a message frame, it waits until the message frame goes completely around the loop and returns before transmitting the next frame. This is part of the loop handshaking process which guarantees that talkers do not send messages faster than other devices can accept them. It also provides error checking capability. That is, if a message frame returns the same as it was sent, the sourcing device assumes that all devices received it correctly.

## A-17. HP 3421A Loop Capabilities

A-18. Table A-1 lists the HP-IL functional capabilities implemented by the HP 3421A.

**Table A-1. HP-IL Functional Capabilities**

| Function | Description |
|---|---|
| R | Receiver Handshake. |
| D | Driver Handshake. |
| AH | Acceptor Handshake. |
| SH1 | Source Handshake. |
| T1,2,3,4,6 | Send Data, Status, Unaddressed if MLA (My Listen Address), Device ID, no Talk Only, Accessory ID. |
| TE0 | No Extended Talker (i.e., no two frame addressing). |
| LE0 | No Extended Listener (i.e., no two frame addressing). |
| L1,3 | Basic Listener, Unaddressed if MTA (My Talk Address), no Listen Only. |
| C0 | No Controller. |
| AA1 | Basic Auto Address, Preset Address of 09 (no address switches). |
| AE0 | No Auto Extended Addressing. |
| AM0 | No Auto Multiple Address. |
| DC2 | Device Clear, Selective Device Clear. |
| DT1 | Device Trigger. |
| RL0 | Remote, Local Lockout are ignored since the HP 3421A has no front panel keys and can only be controlled via HP-IL. |
| SR2 | Basic Service Request and Asynchronous Service Request. |
| PP0 | No Parallel Poll. |
| PD1 | Loop Power Down. |
| DD0 | No Device Dependent Commands. |
| MS0 | No Manual Service Request. |

**Product Line Sales/Support Key**

**Key Product Line**
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**C** Computer Systems
**E** Electronic Instruments & Measurement Systems
**M** Medical Products
**P** Personal Computation Products
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C

## IRELAND

Hewlett-Packard Ireland Ltd.
82/83 Lower Leeson Street
**DUBLIN** 2
Tel: 0001 608800
Telex: 30439
A,C,CM,E,M,P

Cardiac Services Ltd.
Kilmore Road
Artane
**DUBLIN** 5
Tel: (01) 351820
Telex: 30439
M

# SALES & SUPPORT OFFICES
## Arranged alphabetically by country

### ISRAEL
Eldan Electronic Instrument Ltd.
P.O.Box 1270
**JERUSALEM** 91000
16, Ohaliav St.
**JERUSALEM** 94467
Tel: 533 221, 553 242
Telex: 25231 AB/PAKRD IL
A,M

Computation and Measurement Systems (CMS) Ltd.
11 Masad Street
67060
**TEL-AVIV**
Tel: 388 388
Telex: 33569 Motil IL
C,CM,E,P

### ITALY
Hewlett-Packard Italiana S.p.A
Traversa 99C
Via Giulio Petroni, 19
I-70124 **BARI**
Tel: (080) 41-07-44
C,M

Hewlett-Packard Italiana S.p.A.
Via Emilia, 51/C
I-40011 **BOLOGNA** Anzola Dell'Emilia
Tel: (051) 731061
Telex: 511630
C,E,M

Hewlett-Packard Italiana S.p.A.
Via Principe Nicola 43G/C
I-95126 **CATANIA**
Tel: (095) 37-10-87
Telex: 970291
C

Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio 9
I-20063 **CERNUSCO SUL NAVIGLIO**
(Milano)
Tel: (02) 4459041
Telex: 334632
A,C,CM,E,M,P

Hewlett-Packard Italiana S.p.A.
Via C. Colombo 49
I-20090 **TREZZANO SUL NAVIGLIO**
(Milano)
Tel: (02) 4459041
Telex: 322116
C

Hewlett-Packard Italiana S.p.A.
Via Nuova San Rocco a Capodimonte, 62/A
I-80131 **NAPOLI**
Tel: (081) 7413544
Telex: 710698
A**,C,E,M

Hewlett-Packard Italiana S.p.A.
Viale G. Modugno 33
I-16156 **GENOVA PEGLI**
Tel: (010) 68-37-07
Telex: 215238
C,E

Hewlett-Packard Italiana S.p.A.
Via Pelizzo 15
I-35128 **PADOVA**
Tel: (049) 664888
Telex: 430315
A,C,E,M

Hewlett-Packard Italiana S.p.A.
Viale C. Pavese 340
I-00144 **ROMA EUR**
Tel: (06) 54831
Telex: 610514
A,C,E,M,P*

Hewlett-Packard Italiana S.p.A.
Via di Casellina 57/C
I-50018 **SCANDICCI-FIRENZE**
Tel: (055) 753863
C,E,M

Hewlett-Packard Italiana S.p.A.
Corso Svizzera, 185
I-10144 **TORINO**
Tel: (011) 74 4044
Telex: 221079
A*,C,E

### IVORY COAST
S.I.T.E.L.
Societe Ivoirienne de Telecommunications
Bd. Giscard d'Estaing
Carrefour Marcory
Zone 4.A.
Boite postale 2580
**ABIDJAN** 01
Tel: 353600
Telex: 43175
E

S.I.T.I.
Immeuble "Le General"
Av. du General de Gaulle
01 BP 161
**ABIDJAN** 01
Tel: 321227
C,P

### JAPAN
Yokogawa-Hewlett-Packard Ltd.
152-1, Onna
**ATSUGI**, Kanagawa, 243
Tel: (0462) 25-0031
C,CM,E

Yokogawa-Hewlett-Packard Ltd.
Meiji-Seimei Bldg. 6F
3-1 Hon Chiba-Cho
**CHIBA**, 280
Tel: 472 25 7701
C,E

Yokogawa-Hewlett-Packard Ltd.
Yasuda-Seimei Hiroshima Bldg.
6-11, Hon-dori, Naka-ku
**HIROSHIMA**, 730
Tel: 82-241-0611

Yokogawa-Hewlett-Packard Ltd.
Towa Building
2-3, Kaigan-dori, 2 Chome Chuo-ku
**KOBE**, 650
Tel: (078) 392-4791
C,E

Yokogawa-Hewlett-Packard Ltd.
Kumagaya Asahi 82 Bldg
3-4 Tsukuba
**KUMAGAYA**, Saitama 360
Tel: (0485) 24-6563
C,CM,E

Yokogawa-Hewlett-Packard Ltd.
Asahi Shinbun Daiichi Seimei Bldg.
4-7, Hanabata-cho
**KUMAMOTO**, 860
Tel: (096) 354-7311
C,E

Yokogawa-Hewlett-Packard Ltd.
Shin-Kyoto Center Bldg.
614, Higashi-Shiokoji-cho
Karasuma-Nishiiru
Shiokoji-dori, Shimogyo-ku
**KYOTO**, 600
Tel: 075-343-0921
C,E

Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Bldg
4-73, Sanno-maru, 1 Chome
**MITO**, Ibaraki 310
Tel: (0292) 25-7470
C,CM,E

Yokogawa-Hewlett-Packard Ltd.
Meiji-Seimei Kokubun Bldg. 7-8
Kokubun, 1 Chome, Sendai
**MIYAGI**, 980
Tel: (0222) 25-1011
C,E

Yokogawa-Hewlett-Packard Ltd.
Nagoya Kokusai Center Building
47-1, Nagono, 1 Chome
Nakamura-ku
**NAGOYA**, 450
Tel: (052) 571-5171
C,CM,E,M

Yokogawa-Hewlett-Packard Ltd.
Saikyoren Building
1-2 Dote-machi, **OHMIYA**
Saitama 330
Tel: (0486) 45-8031

Yokogawa-Hewlett-Packard Ltd.
Chuo Bldg.,
4-20 Nishinakajima, 5 Chome
Yodogawa-ku
**OSAKA**, 532
Tel: (06) 304-6021
Telex: YHPOSA 523-3624
A,C,CM,E,M,P*

Yokogawa-Hewlett-Packard Ltd.
27-15, Yabe, 1 Chome
**SAGAMIHARA** Kanagawa, 229
Tel: 0427 59-1311

Yokogawa-Hewlett-Packard Ltd.
Daiichi Seimei Bldg.
7-1, Nishi Shinjuku, 2 Chome
Shinjuku-ku, **TOKYO** 160
Tel: 03-348-4611
C,E

Yokogawa-Hewlett-Packard Ltd.
29-21 Takaido-Higashi, 3 Chome
Suginami-ku **TOKYO** 168
Tel: (03) 331-6111
Telex: 232-2024 YHPTOK
A,C,CM,E,M,P*

Yokogawa Hokushin Electric Corp.
9-32 Nokacho 2 Chome
2 Chome Musashino-shi
**TOKYO**, 180
Tel: (0422) 54-1111
Telex: 02822-421 YEW MTK J
A

Yokogawa-Hewlett-Packard Ltd.
Meiji-Seimei
Utsunomiya Odori Building
1-5 Odori, 2 Chome
**UTSUNOMIYA**, Tochigi 320
Tel: (0286) 33-1153
C,E

Yokogawa-Hewlett-Packard Ltd.
Yasuda Seimei Yokohama Nishiguchi Bldg.
30-4 Tsuruya-cho, 3 Chome
**YOKOHAMA** 221
Tel: (045) 312-1252
C,E

### JORDAN
Scientific and Medical Supplies Co.
P.O. Box 1387
**AMMAN**
Tel: 24907, 39907
Telex: 21456 SABCO JO
C,E,M,P

### KENYA
ADCOM Ltd., Inc., Kenya
P.O.Box 30070
**NAIROBI**
Tel: 331955
Telex: 22639
E,M

### KOREA
Samsung Hewlett-Packard Co. Ltd.
Dongbang Yeoeuido Building
12-16th Floors
36-1 Yeoeuido-dong
Yongdeungpo-ku
**SEOUL**
Tel: 784-2666, 784-4666
Telex: 25166 SAMSAN K
A,C,CM,E,M,P

Young In Scientific Co., Ltd.
Youngwha Building
547 Shinsa Dong, Kangnam-ku
**SEOUL** 135
Tel: 5467771
Telex: K23457 GINSCO
A

### KUWAIT
Al-Khaldiya Trading & Contracting
P.O. Box 830
**SAFAT**
Tel: 424910, 411726
Telex: 22481 AREEG KT
Cable: VISCOUNT
E,M,A

Gulf Computing Systems
P.O. Box 25125
**SAFAT**
Tel: 435969
Telex: 23648
P

Photo & Cine Equipment
P.O. Box 270
**SAFAT**
Tel: 2445111
Telex: 22247 MATIN KT
Cable: MATIN KUWAIT
P

W.J. Towell Computer Services
P.O. Box 5897
**SAFAT**
Tel: 2462640
Telex: 30336 TOWELL KT
C

### LEBANON
Computer Information Systems S.A.L.
Chammas Building
P.O. Box 11-6274 Dora
**BEIRUT**
Tel: 89 40 73
Telex: 42309
C,E,M,P

### LIBERIA
Unichemicals Inc.
P.O. Box 4509
**MONROVIA**
Tel: 224282
Telex: 4509
E

### MADAGASCAR
Technique et Precision
12, rue de Nice
P.O. Box 1227
101 **ANTANANARIVO**
Tel: 22090
Telex: 22255
P

### LUXEMBOURG
Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedal
B-1200 **BRUSSELS**
Tel: (02) 762-32-00
Telex: 23-494 paloben bru
A,C,CM,E,M,P

### MALAYSIA
Hewlett-Packard Sales (Malaysia) Sdn. Bhd.
9th Floor
Chung Khiaw Bank Building
46, Jalan Raja Laut
**KUALA LUMPUR**
Tel: 03-986555
Telex: 31011 HPSM MA
A,C,E,M,P*

Protel Engineering
P.O.Box 1917
Lot 6624, Section 64
23/4 Pending Road
Kuching, **SARAWAK**
Tel: 36299
Telex: 70904 PROMAL MA
Cable: PROTELENG
A,E,M

### MALTA
Philip Toledo Ltd.
Birkirkara P.O. Box 11
Notabile Rd.
**MRIEHEL**
Tel: 447 47, 455 66
Telex: 1649
E,M,P

### MAURITIUS
Blanche Birger Co. Ltd.
18, Jules Koenig Street
**PORT LOUIS**
Tel: 20828
Telex: 4296
P

### MEXICO
Hewlett-Packard de Mexico, S.A.
Francisco J. Allan #30
Colonia Nueva
Los Angeles 27140
**COAHUILA**, Torreon
Tel: 37220
P

Hewlett-Packard de Mexico, S.A.
Monti Morelos 299
Fraccionamiento Loma Bonita 45060
**GUADALAJARA**, Jalisco
Tel: 316630/314600
Telex: 0684 186 ECOME
P

## MEXICO (Cont'd)

Microcomputadoras Hewlett-Packard, S.A.
Monti Pelvoux 115
**LOS LOMAS,** Mexico, D.F.
Tel: 520-9127
P

Hewlett-Packard Mexicana, S.A de C.V.
Av. Periferico Sur No. 6501
Tepepan, Xochimilco
16020 **MEXICO D.F.**
Tel: 6-76-46-00
Telex: 17-74-507 HEWPACK MEX
A,C,CM,E,M,P

Hewlett-Packard De Mexico (Polanco)
Avenida Ejercito Nacional #579
2day3er piso
Colonia Granada 11560
**MEXICO D.F.**
Tel: 254-4433
P

Hewlett-Packard De Mexico, S.A. de C.V.
Czda. del Valle
409 Ote. 4th Piso
Colonia del Valle
Municipio de Garza Garciá
66220 **MONTERREY,** Nuevo León
Tel: 78 42 41
Telex: 038 410
P

## MOROCCO

Etablissement Hubert Dolbeau & Fils
81 rue Karatchi
B.P. 11133
**CASABLANCA**
Tel: 3041-82, 3068-38
Telex: 23051, 22822
E

Gerep
2, rue Agadir
Boite Postale 156
**CASABLANCA** 01
Tel: 272093, 272095
Telex: 23 739
P

Sema-Maroc
Dept. Seric
6, rue Lapebie
**CASABLANCA**
Tel: 260980
Telex: 21641
C,P

## NETHERLANDS

Hewlett-Packard Nederland B.V.
Startbaan 16
1187 XR **AMSTELVEEN**
P.O. Box 667
NL1180 AR **AMSTELVEEN**
Tel: (020) 547-6911
Telex: 13 216 HEPA NL
A,C,CM,E,M,P

Hewlett-Packard Nederland B.V.
Bongerd 2
NL 2906VK **CAPELLE A/D IJSSEL**
P.O. Box 41
NL 2900AA **CAPELLE A/D IJSSEL**
Tel: (10) 51-64-44
Telex: 21261 HEPAC NL
C,E

Hewlett-Packard Nederland B.V.
Pastoor Petersstraat 134-136
NL 5612 LV **EINDHOVEN**
P.O. Box 2342
NL 5600 CH **EINDHOVEN**
Tel: (040) 326911
Telex: 51484 hepae nl
A,C,E,M,P

## NEW ZEALAND

Hewlett-Packard (N.Z.) Ltd.
5 Owens Road
P.O. Box 26-189
Epsom, **AUCKLAND**
Tel: 687-159
Cable: HEWPAK Auckland
C,CM,E,P*

Hewlett-Packard (N.Z.) Ltd.
4-12 Cruickshank Street
Kilbirnie, **WELLINGTON 3**
P.O. Box 9443
Courtenay Place, **WELLINGTON 3**
Tel: 877-199
Cable: HEWPACK Wellington
C,CM,E,P

Northrop Instruments & Systems Ltd.
369 Khyber Pass Road
P.O. Box 8602
**AUCKLAND**
Tel: 794-091
Telex: 60605
A,M

Northrop Instruments & Systems Ltd.
110 Mandeville St.
P.O. Box 8388
**CHRISTCHURCH**
Tel: 488-873
Telex: 4203
A,M

Northrop Instruments & Systems Ltd.
Sturdee House
85-87 Ghuznee Street
P.O. Box 2406
**WELLINGTON**
Tel: 850-091
Telex: NZ 3380
A,M

## NIGERIA

Elmeco Nigeria Ltd.
46, Calcutta Crescent Apapa
P.O. Box 244and
**LAGOS**
E

## NORTHERN IRELAND

**See United Kingdom**

## NORWAY

Hewlett-Packard Norge A/S
Folke Bernadottes vei 50
P.O. Box 3558
N-5033 **FYLLINGSDALEN** (Bergen)
Tel: 0047/5/16 55 40
Telex: 76621 hpnas n
C,E,M

Hewlett-Packard Norge A/S
Osterndalen 16-18
P.O. Box 34
N-1345 **ØSTERÅS**
Tel: 0047/2/17 11 80
Telex: 76621 hpnas n
A,C,CM,E,M,P

## OMAN

Khimjil Ramdas
P.O. Box 19
**MUSCAT/SULTANATE OF OMAN**
Tel: 745601
Telex: 5289 BROKER MB MUSCAT
P

Suhail & Saud Bahwan
P.O.Box 169
**MUSCAT/SULTANATE OF OMAN**
Tel: 734201
Telex: 5274 BAHWAN MB
E

Imtac LLC
P.O. Box 8676
**MUTRAH/SULTANATE OF OMAN**
Tel: 601695
Telex: 5741 Tawoos On
A,C,M

## PAKISTAN

Mushko & Company Ltd.
House No. 16, Street No. 16
Sector F-6/3
**ISLAMABAD**
Tel: 824545
Cable: FEMUS Islamabad
A,E,M,P*

Mushko & Company Ltd.
Oosman Chambers
Abdullah Haroon Road
**KARACHI** 0302
Tel: 524131, 524132
Telex: 2894 MUSKO PK
Cable: COOPERATOR Karachi
A,E,M,P*

## PANAMA

Electronico Balboa, S.A.
Calle Samuel Lewis, Ed. Alfa
Apartado 4929
**PANAMA** 5
Tel: 64-2700
Telex: 3483 ELECTRON PG
A,CM,E,M,P

## PERU

Cía Electro Médica S.A.
Los Flamencos 145, Ofc. 301/2
San Isidro
Casilla 1030
**LIMA** 1
Tel: 41-4325, 41-3705
Telex: Pub. Booth 25306 PEC PISIDR
CM,E,M,P

SAMS
Arenida Republica de Panama 3534
San Isidro, LIMA
Tel: 419928/417108
Telex: 20450 PE LIBERTAD
A,C,P

## PHILIPPINES

The Online Advanced Systems Corp.
2nd Floor, Electra House
115-117 Esteban Street
Legaspi Village, Makati
P.O. Box 1510
Metro **MANILA**
Tel: 815-38-10 (up to 16)
Telex: 63274 ONLINE PN
A,C,E,M,P

## PORTUGAL

Mundinter Intercambio
Mundial de Comércio S.A.R.L.
Av. Antonio Augusto Aguiar 138
Apartado 2761
**LISBON**
Tel: (19) 53-21-31, 53-21-37
Telex: 16691 munter p
M

Soquimica
Av. da Liberdade, 220-2
1298 **LISBOA** Codex
Tel: 56-21-82
Telex: 13316 SABASA
A

Telectra-Empresa Técnica de Equipmentos Eléctricos S.A.R.L.
Rua Rodrigo da Fonseca 103
P.O. Box 2531
**LISBON** 1
Tel: (19) 68-60-72
Telex: 12598
CM,E

C.P.C.S.I.
Rua de Costa Cabral 575
4200 **PORTO**
Tel: 499174/495173
Telex: 26054
C,P

## PUERTO RICO

Hewlett-Packard Puerto Rico
101 Muñoz Rivera Av
Esu. Calle Ochoa
**HATO REY,** Puerto Rico 00918
Tel: (809) 754-7800
A,C,CM,M,E,P

## QATAR

Computer Arabia
P.O. Box 2750
**DOHA**
Tel: 428555
Telex: 4806 CHPARB
P

Nasser Trading & Contracting
P.O.Box 1563
**DOHA**
Tel: 422170
Telex: 4439 NASSER DH
M

## SAUDI ARABIA

Modern Electronics Establishment
Hewlett-Packard Division
P.O. Box 281
Thouqbah
**AL-KHOBAR** 31952
Tel: 895-1760, 895-1764
Telex: 671 106 HPMEEK SJ
Cable: ELECTA AL-KHOBAR
C,E,M

Modern Electronics Establishment
Hewlett-Packard Division
P.O. Box 1228
**JEDDAH**
Tel: 644 96 28
Telex: 4027 12 FARNAS SJ
Cable: ELECTA JEDDAH
A,C,CM,E,M,P

Modern Electronics Establishment
Hewlett-Packard Division
P.O.Box 22015
**RIYADH** 11495
Tel: 476-3030
Telex: 202049 MEERYD SJ
A,C,CM,E,M,P

Abdul Ghani El Ajou Corp.
P.O. Box 78
**RIYADH**
Tel: 40 41 717
Telex: 200 931 EL AJOU
P

## SCOTLAND

**See United Kingdom**

## SENEGAL

Societe Hussein Ayad & Cie
76, Avenue Georges Pompidou
B.P. 305
**DAKAR**
Tel: 32339
Cable: AYAD-Dakar
E

Moneger Distribution S.A.
1, Rue Parent
B.P. 148
**DAKAR**
Tel: 215 671
Telex: 587
P

Systeme Service Conseil (SSC)
14, Avenue du Parachois
**DAKAR ETOILE**
Tel: 219976
Telex: 577
C,P

## SINGAPORE

Hewlett-Packard Singapore (Sales) Pte. Ltd.
08-00 Inchcape House
450-2 Alexandra Road
Alexandra P.O. Box 58
**SINGAPORE,** 9115
Tel: 4731788
Telex: 34209 HPSGSO RS
Cable: HEWPACK, Singapore
A,C,E,M,P

Dynamar International Ltd.
Unit 05-11 Block 6
Kolam Ayer Industrial Estate
**SINGAPORE** 1334
Tel: 747-6188
Telex: 26283 RS
CM

## SOUTH AFRICA

Hewlett-Packard So Africa (Pty.) Ltd.
P.O. Box 120
Howard Place **CAPE PROVINCE** 7450
Pine Park Center, Forest Drive, Pinelands
**CAPE PROVINCE** 7405
Tel: (021) 53 7954
Telex: 57-20006
A,C,CM,E,M,P

Hewlett-Packard So Africa (Pty.) Ltd.
2nd Floor Juniper House
92 Overport Drive
**DURBAN** 4067
Tel: (031) 28-4178
Telex: 6-22954
C

Hewlett-Packard So Africa (Pty.) Ltd.
6 Linton Arcade
511 Cape Road
Linton Grange
**PORT ELIZABETH** 6001
Tel: 041-301201
Telex: 24-2916
C

# SALES & SUPPORT OFFICES
## Arranged alphabetically by country

### SOUTH AFRICA (Cont'd)
Hewlett-Packard So Africa (Pty.) Ltd.
Fountain Center
Kalkden Str.
Monument Park Ext 2
**PRETORIA** 0105
Tel: (012) 45 57258
Telex: 3-21063
C,E

Hewlett-Packard So Africa (Pty.) Ltd.
Private Bag Wendywood
**SANDTON** 2144
Tel: 802-5111, 802-5125
Telex: 4-20877 SA
Cable: HEWPACK Johannesburg
A,C,CM,E,M,P

### SPAIN
Hewlett-Packard Española S.A.
Calle Entenza, 321
08029 **BARCELONA**
Tel: 3/322 24 51, 321 73 54
Telex: 52603 hpbee
A,C,E,M,P

Hewlett-Packard Española S.A.
Calle San Vicente S/N
Edificio Albia II-7B
48001 **BILBAO**
Tel: 4/423 83 06
A,C,E,M

Hewlett-Packard Española S.A.
Crta. de la Coruña, Km. 16, 400
Las Rozas
E-**MADRID**
Tel: (1) 637.00.11
Telex: 23515 HPE
C,M

Hewlett-Packard Española S.A.
Avda. S. Francisco Javier, S/N
Planta 10. Edificio Sevilla 2
41005 **SEVILLA**
Tel: 54/64 44 54
Telex: 72933
A,C,M,P

Hewlett-Packard Española S.A.
Isabel La Catolica, 8
46004 **VALENCIA**
Tel: 0034/6/351 59 44
C,P

### SWEDEN
Hewlett-Packard Sverige AB
Ostra Tullgatan 3
S-21128 **MALMÖ**
Tel: (040) 70270
Telex: (854) 17886 (via Spånga office)
C,P

Hewlett-Packard Sverige AB
Skalholtsgatan 9, Kista
Box 19
S-16393 **SPÅNGA**
Tel: (08) 750-2000
Telex: (854) 17886
Telefax: (08) 7527781
A,C,CM,E,M,P

Hewlett-Packard Sverige AB
Frötallsgatan 30
S-42132 **VÄSTRA-FRÖLUNDA** (Gothenburg)
Tel: (031) 49-09-50
Telex: (854) 17886 (via Spånga office)
A,C,CM,E,M,P

### SUDAN
Mediterranean Engineering & Trading Co. Ltd.
P.O. Box 1025
**KHARTOUM**
Tel: 41184
Telex: 24052
C,P

### SWITZERLAND
Hewlett-Packard (Schweiz) AG
Clarastrasse 12
CH-4058 **BASEL**
Tel: (61) 33-59-20
A

Hewlett-Packard (Schweiz) AG
7, rue du Bois-du-Lan
Case postale 365
CH-1217 **MEYRIN** 1
Tel: (0041) 22-83-11-11
Telex:27333 HPAG CH
C,CM

Hewlett-Packard (Schweiz) AG
Allmend 2
CH-8967 **WIDEN**
Tel: (0041) 57 31 21 11
Telex: 53933 hpag ch
Cable: HPAG CH
A,C,CM,E,M,P

### SYRIA
General Electronic Inc.
Nuri Basha Ahnaf Ebn Kays Street
P.O. Box 5781
**DAMASCUS**
Tel: 33-24-87
Telex: 411 215
Cable: ELECTROBOR DAMASCUS
E

Middle East Electronics
P.O.Box 2308
Abu Rumaneh
**DAMASCUS**
Tel: 33 45 92
Telex: 411 771
M

### TAIWAN
Hewlett-Packard Taiwan
Kaohsiung Office
11/F, 456, Chung Hsiao 1st Road
**KAOHSIUNG**
Tel: (07) 2412318
C,E

Hewlett-Packard Taiwan
8th Floor, Hewlett-Packard Building
337 Fu Hsing North Road
**TAIPEI**
Tel: (02) 712-0404
Telex: 24439 HEWPACK
Cable:HEWPACK Taipei
A,C,CM,E,M,P

Ing Lih Trading Co.
3rd Floor, 7 Jen-Ai Road, Sec. 2
**TAIPEI 100**
Tel: (02) 3948191
Cable: INGLIH Taipei
A

### THAILAND
Unimesa Co. Ltd.
30 Patpong Ave., Suriwong
**BANGKOK** 5
Tel: 235-5727
Telex: 84439 Simonco TH
Cable: UNIMESA Bangkok
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Telex: 87699-BEQUIPT TH
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Immeuble Sagap
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### TRINIDAD & TOBAGO
Caribbean Telecoms Ltd.
Corner McAllister Street & Eastern Main Road, Laventille
P.O. Box 732
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Telex: 22561 CARTEL WG
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Computer and Controls Ltd.
P.O. Box 51
66 Independence Square
**PORT-OF-SPAIN**
Tel: 62-279-85
Telex: 3000 POSTLX WG, ACCT LOO9O AGENCY 1264
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Feral Assoc.
8 Fitzgerald Lane
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### TUNISIA
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Telex: 13238
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94, Av. Jugurtha, Mutuelleville
1002 **TUNIS-BELVEDERE**
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23, bis Rue de Marseille
**TUNIS**
Tel: 253-821
Telex: 14812 CABAM TN
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### TURKEY
E.M.A.
Mediha Eldem Sokak No. 41/6
Yenisehir
**ANKARA**
Tel: 319175
Telex: 46912 KTX TR
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Teknim Company Ltd.
Iran Caddesi No. 7
Kavaklidere
**ANKARA**
Tel: 275800
Telex: 42155 TKNM TR
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Saniva Bilgisayar Sistemleri A.S.
Buyukdere Caddesi 103/6
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**ISTANBUL**
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Telex: 26345 SANI TR
C,P

Best Inc.
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**SHARJAH**
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Emitac Ltd.
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Emitac Ltd.
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## Arranged alphabetically by country

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